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S. GOLD AND W. F. TUBESING.

PROPOSED DRIVE SUBWAY AND
OVERHEAD CROSSING OF THE
SAINT PAUL RAILROAD ALONG
THE NORTHWESTERN SHORE
OF LAKE MONONA.

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PROPOSED DRIVE, SUBWAY AND OVERHEAD
CROSSING OF THE SAINT PAUL RAILROAD ALONG
THE NORTHWESTERN SHORE OF LAKE MONONA.

by

SOLON GOLD

and

WILLIAM FRED TUBESING

A Thesis Submitted for the Degree of

BACHELOR OF SCIENCE

Civil Engineering Course

UNIVERSITY OF WISCONSIN

1905

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Introduction.

For a number of years the Park and Pleasure Drive Association of Madison has considered the abolishing of grade crossings in Madison. It is the object of this thesis to present a scheme, furnish plans, estimate and specifications for the elimination of the grade crossing at West Washington Avenue. It is proposed to make a detour by means of a drive constructed along the northwestern shore of Lake Monona. This drive will be built on material which will be taken out of the lake bottom and filled in along the shore by means of an hydraulic dredge. The drive will pass underneath the C.M. & St.P.R.R. tracks by means of a subway. From the east approach of the subway the drive will extend along the shore at a gradual grade of 2.2% to an overhead crossing at the foot of Bassett street. This latter crossing is of a plate girder design and will have an earth filled approach on Bassett street from West Wilson street to the bridge. To give the drive a rustic appearance it is proposed to plant shrubbery and trees along the drive, thus carrying out the idea of park design.

The advantages gained by such an improvement

will be manifold. As about one-fourth of the vehicles entering Madison come via West Washington avenue and as there is a train of some kind or other pulling out or switching in the West Madison yards of the St. Paul railroad every five minutes it is evident how greatly the chance of an accident will be lessened by doing away with this grade crossing. Vehicles and pedestrians will not be detained by trains and the drive itself will be an improvement because of its position along the lake.

In order to carry out this piece of work it is necessary to find some means of obtaining the necessary funds which would be adequate to pay for the interest charges on such an undertaking. With this point in view it is proposed to rent the hydraulic dredge which has been used in making available lands in the south eastern part of Madison. The dredge will be brought into the north western corner of Lake Monona, will take the earth out of the lake bottom 300 feet from shore and will fill in the shallow shore for a distance of from 200 to 300 feet. The drive will skirt the edge of this fill and the made land adjacent to the drive will be converted into lots. These lots should bring a good price as they will front on a broad artistic and rustic

drive which will afford an excellent view of the lake and also give a fairly deep lake front.

The planting of trees and shrubbery along the drive will hide the manufacturing districts to a certain extent and thus provide a picturesque drive from the one end of Madison to the other.

Property in this part of the town is very cheap for the simple reason that very little improvement has been made.

The sanitary conditions at present also need immediate attention. The decay of weeds, dumping of refuse and consequent formation of stagnant pools of water afford excellent breeding places for mosquitoes. Mosquitoes are not only annoying but it is a well known fact that they transmit malaria to the human system. The odors coming from these pools in warm weather also need consideration. These facts bear evidence that the filling in of this part of the lake is a dire necessity to the community. Having now shown the necessities for the improvement, offered a scheme to obtain the revenue for the same, the engineering side of the subject will be taken up next.

The Survey.

It became evident from a reconnoissance survey that the only feasible plan to go underneath the St. Paul tracks was at the switch stand of the spur track leading to the ware-houses to the west of the main track. This switch stand is about 1400 feet north of the crossing of the C.M. & St.P.R.R. and the C. & N.W.R.R. at the triangle on Lake Monona. With this point in view a line of levels was run from the B.M. on West Washington avenue one block west of the St. Paul tracks. Beginning in the middle of West Washington avenue and the main track of the C.M. & St.P.R.R. a line of levels, at the base of the rails (stations taken every hundred feet), was run from this point to the crossing on the triangle.

It became obvious from the profile that was plotted from these notes that there was a sag of about a foot and a half in the tracks of the C.M. & St.P.R.R. from the crossing at the triangle to a point about half way between West Washington avenue and West Main street. Raising the track here to a uniform grade of .308% would materially better the same and would also add a foot and a half head room to the subway. As head room is one of the dominating

obstacles of the subway it is proposed to petition the St. Paul railroad to raise the grade at this point.

In order to get an idea of the relative elevations of the lake bottom, shore, and adjacent property a stadia survey was made. The traverse was not a closed one but was run more like a meander line. The stadia work on land was done in the usual way. The soundings of the lake bottom, however, were taken in a somewhat different manner. The instrument was set up over the various stations and the azimuth and distance read. The rodman, after making a hole in the ice, took a sounding at the point and called off the depth to the instrument man. These soundings were taken so as to skirt the shore, the distance between some ranging from 50 to 100 feet and extending about 300 feet out. These notes were platted as shown in the map in the back of the book. No contour lines are shown because the shots on land were taken only to get a relative idea of the lay of the same and consequently were few in number. The best way of representing same was therefore thought to be to plat the actual observed differences of elevation referred to city datum.

The map represents that section of Madison in which the proposed drive, subway, and overhead crossing is to be built. The blue numbers refer to the lake bottom which is referred to city datum and are minus (-) The brown figures represent elevations on land, are plus (+) and are also referred to city datum. The fine red lines show the traverse which was run, while the heavy red lines show the proposed route of the drive, subway and overhead crossing. The cross-hatched area represent buildings while everything in black represents conditions as they are at present.

The Subway.

The engineering success of the proposed improvement depends mainly on the construction of the subway while the filling and overhead crossing are obstacles which can be easily overcome. In the design of the subway four important questions arose, viz.

1. Could the buoyant effect be overcome?
2. Could the structure be made impervious so as to keep out the waters of Lake Monona?
3. Could the surface drainage waters be taken care of economically?
4. Could a design of the top cover of the subway be brought within a limit of 30" including ties and rails.

Computations showed that the buoyant effect was 585,000 lbs., while the weight of the subway was 2,336,830 lbs. This gave a factor of safety against buoyancy of 3.98.

For years numbers of experiments have been made to make concrete impervious. Various substances have been mixed with the cement to bring about such a condition but all have been only partially successful. Different European experts have been consulted and they all speak very

favorably of using asphalt or pitch. It was also found that various railroads were at present protecting their concrete structures from the seepage of waters by applying a coat of asphalt cut with naphtha. With these considerations in view it is proposed, as a first precaution, to make a very rich concrete of 1+2-3.5 mixture and to insure that the same will be well mixed and tamped. Second, the reinforcing material will prevent cracking. Thirdly, to doubly insure the structure against seepage it is proposed to paint the outside walls of the subway, when the same are entirely below the water line with a coat of asphalt cut with naphtha. The surface will then be covered with an asphaltic mastic composed of 1 part asphalt to four parts of sand, the same to be smoothed off with hot smoothing irons and thoroughly tamped and pressed to place.

As the surface drainage will be so taken care of that the runoff into the subway will be small in amount it is proposed to use a water jet suction pump to raise the water out of the pit and discharge the same into a run-off pipe.

Having gained a foot and a half head room it will next be shown how the cover of the subway was reduced

to a minimum. Computations showed that ten 15", 100# I beams twenty six feet long with a clear span of twenty feet could be used if five were placed under each rail, the load being transmitted to all of them by means of the ties.. The I beams will be joined by means of $7/8$ inch rods and nuts. The total depth of cover, including a five inch rail, will be, I beam, 15", rail 5", tie 6", total 26". Corrugated sheet metal will be placed between the I beams and loose rock will be filled in between the ties and beams.

COMPUTATIONS.

Moment due to dead load; 200# per lineal foot of rail;
500# per lineal foot of I beam; gravel 120(6.25). Total
load per lineal foot 1,450#.

Moment $1/8wl$ 88,000' #

Max. moment for Cooper's E 50 loading. 307,100' #

Impact $307,100 \times 0.932$ 286,217' #

Total 681,317' #

$\frac{681317 \times 12}{15} = 545,054$ section

$\frac{545.05}{120.10} = 4.54$; Use 5-15"

modulus about 1-1

100# I beams.

Flange width 6.77"

Considering the Buoyant Effect.

The force tending to float the structure is equal to the
weight of the amount of water displaced.

Depth at high water, elevation 2.15 9.75'

Width of base 26.50'

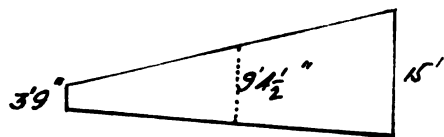
Length 30' 100' 130.00'

Volume 130 26.5 9.75 9,360.00 cu. '

Weight of displaced water 585,000.00#

Water weighs 62.5# per cubic foot.

Weight of the concrete.

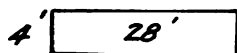


Volume of 4 wing walls using the
prismoidal formula $\frac{L}{6}(A_1 + 4A_m + A_2)$

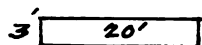
$$1\frac{1}{2}' \times 1\frac{1}{2}' \times 2'6'' \quad \frac{4(50)}{6}(4.2 + 4(16.9) + 37.5) = 3,643 \text{ cu.ft.}$$

Volume of bottom between wings. Mean height 3.5 ft.

Mean width 24.0 "



$$\text{for two ends } \frac{2(50)}{6}(60 + 336 + 112)$$



$$= 8,466 \text{ cu.'}$$

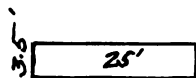
$$\text{Volume of base of subway } 20 \times 3 \times 30 = 1,800 \text{ cu.'}$$

$$\text{Volume of sides. } \frac{2.6 + 3.08}{2} (15)(30) = 1,278 \text{ cu.'}$$



$$2 \times 1278 = 2,556 \text{ cu.'}$$

Volume of Top Railing.



End area 3.06 sq'

$$2(3.06 \times 25) = 153 \text{ cu.'}$$

$$\text{Concrete in Road-bed } 14(1.25) + 3.42(0.5) = 19.21 \text{ cu.'}$$

$$\text{Total number of cubic feet of concrete} = 16,637$$

$$\text{Total weight of Concrete (at 140# per cu.'}) = 2,329,180\#$$

$$\text{I beams } 22'-15''-100\# \text{ I} = 2,200\#$$

Dead load of ties, rails, spikes, etc. (Johnson's Framed Str)

4.5# per foot (B.M.) 100# per foot for rails, spikes, joint

$$\frac{25 \times 12}{6} \times 4.5 \times 225\# \text{ Double track } 2 \times (225) = 450\# \text{ (ties)}$$

$$25(100)2 \text{ Weight of spikes, rails, etc.} = 5,000\#$$

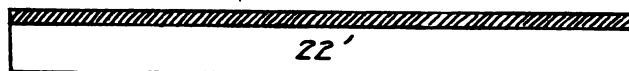
$$\text{Total weight of structure} = 2,336,830\#$$

As the weight of the displaced water is only 585,000# there is no danger that it will float.

Figuring the Size of the Floor of the Subway.

Span 22 ft. Head 9.75 ft. Area of base(considering the force of the water 22,sq. ft. $P = \text{span}(62.5)\text{head}$

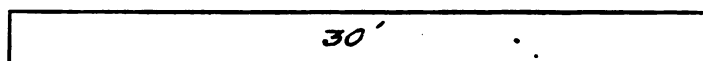
$$\text{Pressure } 22(62.5)9.75 = 13,400\#$$



$$M \frac{WL}{8} = \frac{13400 \cdot 22 \cdot 12}{8} = 442,000\#$$

$$Y = \frac{442000}{4460} = 9.94 \text{ (depth of beam in inches)}$$

$$a = 0.086 \times 9.94 = 0.86 \text{ sq. inches of metal per foot.}$$



$$Y = 11.05 - a = 0.856$$

(Johnson's Tables)

$$\text{At end Pressure} = 30(62.5)(5) = 9400\#$$

$$M = \frac{WL}{8} = \frac{9400(30)(12)}{8} = 422,000\#$$

$$\text{Colpitt's Tables } Y = 9.55" \quad a = 0.82"$$

$$\text{Johnson's } "" \quad Y = 10.80" \quad a = 0.856"$$

Assuming no pressure exerted upward, calculating roadway, and assuming concrete at 150# per cu.ft. and live load at 250# per square foot., total 400# per foot.

22'

$$\text{Total } M = \frac{400(\overline{22})^2(\overline{12})}{8} = 3,500,000\text{"}\#$$

30'

$$\text{Total } M = \frac{400(\overline{30})^2(\overline{12})}{8} = 6,480,000\text{"}\#$$

From Johnson's Tables $M = 3,500,000$

$$Y = 31.15$$

$$a = 2.41$$

$$e = 3.12\text{"}$$

for 6,480,000

$$Y = 42.50$$

$$a = 3.23$$

$$e = 4.25\text{"}$$

According to Buell and Hill, in figuring for thermal and shrinkage stresses in steel with elastic limit at 50,000# it will be necessary to have 0.82% of steel.

$0.0082 \times 144 = 1.18$ sq.in. per sq.ft. Using $7/8$ inch rods requires 7.5 inch spacing. Decided to use 6" spacing.

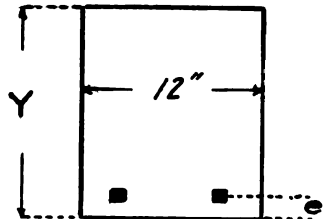
$$Y = \frac{3500000}{4460} = 25\text{"}$$

$$a = 0.086 (Y) = 2.15 \text{ sq.in. of metal / ft.}$$

$$e = 0.1 Y = 2.5\text{"}$$

$$Y = \frac{6480000}{4460} = 38.5\text{"}$$

$$a = 0.086(38.5) = 3.4 \text{ sq.in. of metal per foot. } e = 0.1 \times Y = 3.85\text{"}$$



Bearing at Ends of I Beams.

1450# per lineal foot for 5 beams, span 22 ft.

Reaction, per beam, $\frac{1450 \times 11}{5} = 3190\# + \text{impact } (2966) = 6156$

Max. compression to resist crushing 2,000#/sq.in.

$$\frac{6160}{2000} = 3.08 \text{ sq.in.}$$

Flange width 6.77", bearing required 3.08 sq.in.

Therefore beams resting for a distance of one foot will give sufficient bearing.

Bearing Power of Sand Bottom.

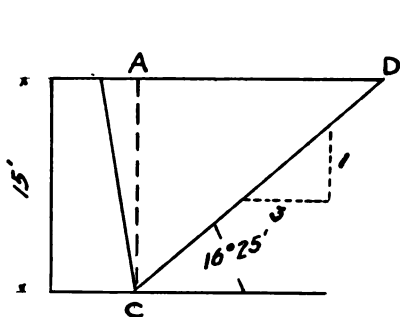
Trautwine gives 2 to 3 ton per square foot as a safe load, Rankine 1 to 1.5 ton. Approximately 12,820# are distributed over 300 square feet which will give $\frac{12820}{300} =$

42.8#/sq.ft.

Therefore the bearing power of soil is sufficient.

Figuring the Sides of Subway.

Assuming the surface of rupture to be a plane, that the point of application of the lateral pressure of the earth is one-third the height, measured from the bottom, and that the pressure on the face is normal to the pressure on the back face



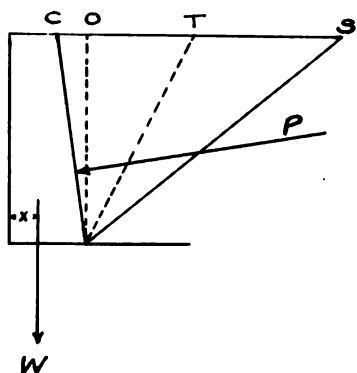
$$t = h \times \tan 0.5 \frac{AC \cdot D}{3W}$$

$$(90^\circ - 16^\circ 25') / 2 = 36^\circ 47'$$

$$\tan 36^\circ 47' = 0.748$$

$$t = 15 \times 0.748 \sqrt{\frac{110}{3(140)}} = 5.7 \text{ feet.}$$

$$\overline{OT}/15 = \tan 22^\circ 30' \therefore \overline{ot} = 15(0.422) = 6.33$$



$$P = \frac{110 \times 40.10}{2} = 2210$$

$$2210 \times 5 = X \cdot 56.85 (\text{area}) \times 140$$

$$X = \frac{11050}{140 \cdot 56.85} = 1.39 \text{ ft.}$$

$$2210 \times 5 = X(35.4)(140)$$

$$X = 1105 / 14(35.4) = 2.23 \text{ ft.}$$

ESTIMATE.

Concrete Steel Subway.

Steel reinforcing 71000# at 5¢ a lb.	\$3550.00
Concrete 510 cu.yd. at \$6.00 per cu.yd.	3060.00
Sheeting 360' at 60¢ per ft.	216.00
Bracing at \$40.00 per thousand B.M.	1508.00
Railing 56 ft at \$5.00 per ft.	280.00
Water-jet pump.	400.00
Water Proofing at 50¢ per sq.yd.	59.00
I-beams, plates, nuts etc. 43,233 lbs. at 5¢	2162.00

Plus 15%

	<u>1685.00</u>
Total	12920.00

OVERHEAD CROSSING.

The overhead crossing at the foot of Bassett St., will rest upon concrete abutments with a clear opening of 48 ft. This is the minimum allowable clear opening, as the right of way of the railroad company at this point is 48 ft. - 33 ft. on the water side and 15 ft. on the land side, from the center of the tracks. It will be made of a through girder design with only 1 walk. This walk will be on the outside of the west girder and will be 6 ft. from center of girder to outside edge. The girders will be placed 24 ft. apart. The length will be 50 ft. C. to C. and 52 ft. out to out.

The floor of roadway will consist of an asphalt paving placed upon concrete steel crossbeams.



Cross Section of Roadway

The % of steel to be used in the crossbeams will be obtained from the following formula, which is very largely used in practice: $P \frac{F_c}{F_s} = 0.2$ in which P % of steel; 0.2 an experimental constant; and (F_c) and (F_s) are

the safe unit stresses of the concrete and steel respectively.

The crossbeams will be prepared 6 months before being used. This will give the concrete a safe compressive stress of 700 lbs. per sq. in. The stress in the steel reinforcing rods will be taken at 12,000 lbs per sq. in. Substituting in the above formula, the % of steel is found to be 1.17.

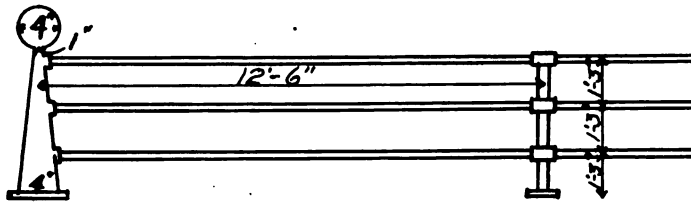
The crossbeams will be 12 ft. long and will be placed abutting one another so as to form a solid flooring. This flooring will be supported upon I- Beams stringers.

The intermediate stringers will be spaced 6 ft. apart and the 2 outside ones will be placed 1 ft. from the center of girders. The stringers will be riveted to the web of the floor beams so as to bring the top surface of the crossbeams flush with the top surface of the floorbeams.

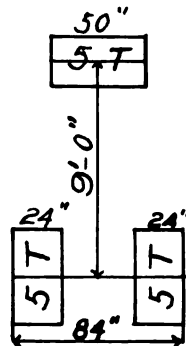
The floor beams will be spaced 12.5 ft. apart and will be riveted to the webs of the girders.

The sidewalk will consist of a concrete flooring reinforced with iron netting and will be supported upon 2 stringers spaced 5 ft. apart, the inner one being 6 in.

from the center of girder. The stringers will rest upon brackets riveted to the web of the girder at the point of connection of the floorbeams. Upon these brackets at 3 in. from the edge of the walk will be supported a rail fence, a sketch of which is shown below:



The bridge will be designed to carry, in addition to its own weight, a live load due to a crowd of people, which will be taken at 100 lbs. per sq. ft. A concentrated load due to a 15 ton roller, plan of which is shown below, will also be provided for.



DESIGN.

Floor System.

CROSSBEAMS: The beams will be computed as consisting of simple spans of 6 ft. 0 in. The maximum live load moment will occur when one wheel of the roller is at the center.

Assuming the total load as being concentrated at the center, Maximum moment = $\frac{10000 \times 6 \times 12}{4} = 180,000 \text{ in. lbs.}$

For computing the section the following formula which is very largely used in practice will be employed:

$$\frac{M}{bd^2} = 0.85 \times P \times F_s$$

in which M Maximum binding moment; b and d breadth and depth of beam respectively; P % of steel; F_s Fibre stress of the steel and .85 an experimental constant.

Assuming b as 24 in. and substituting in above formula we get: $\frac{180,000}{24d^2} = 0.85 \times .0117 \times 12000$
from which $d = 7.94$.

REDESIGN OF CROSSBEAMS: In the redesign the weight of the beam and the superincumbent material will be considered. Assume new depth of beam as 8.5 ft.

The weight of the material per cu. ft. will be taken as follows:

Steel Concrete	150 lbs.
Concrete	140 "
Asphalt	100 "
Binder	125 "

Using the above values the weight supported by the crossbeam will be:

$$\begin{aligned}
 \text{Crossbeam} & 6 \times \frac{8.5}{12} \times 2 \times 150 = 1275 \text{ lbs.} \\
 \text{Crown} & 6 \times 2 \times \frac{3.3}{12} \times 140 = 470 \text{ " } \\
 \text{Binder} & 6 \times 2 \times \frac{1}{12} \times 125 = 125 \text{ " } \\
 \text{Asphalt} & 6 \times 2 \times \frac{2}{12} \times 100 = \frac{200}{12} \text{ " } \\
 & \text{Total } 2070 \text{ " }
 \end{aligned}$$

Maximum moment due to dead load

$$\frac{2070 \times 6 \times 12}{8} = 18700 \text{ in. lbs.}$$

Total dead and live load moment

$$180000 + 18700 = 198700 \text{ in. lbs.}$$

Substituting in above formula we get:

$$d = 8.3$$

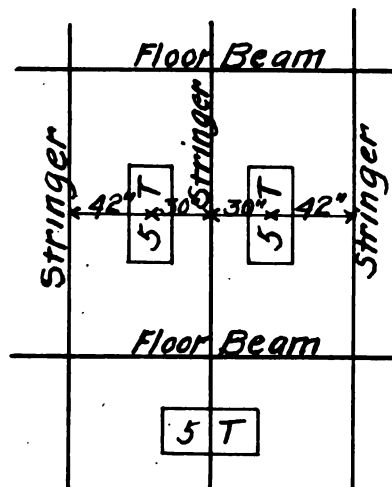
The assumed depth of 8.5 in. will be used.

STRINGERS:

Intermediate Stringers: Here also as well as in future calculations the weight of the roller wheels will

be assumed as being concentrated at a point.

To get the maximum live load moment upon the stringer the 2 rear wheels will be equidistant from the center line of stringer and midway between the floor beams, as shown in sketch, in which case the load on stringer will be,



$$\frac{2 \times 10000 \times 42}{72} = 11,700 \text{ lbs.}$$

The dead load on stringer

$$\frac{12.5}{2} \times 2070 = 12,900 \text{ lbs.}$$

Weight of stringer (assumed at 40 lbs per foot) = 500 lbs.

$$\text{Total maximum end shear} = \frac{12900 + 500 + 11,700}{2} = 12500 \text{ lbs.}$$

$$\text{Total maximum moment} = 12.5 \times 12 \left(\frac{11700}{4} + \frac{13400}{8} \right) =$$

690,000 in. lbs.

From tables in Cambria a 12-I-B-105 weight 40 Lbs. will carry 710,00 in. Lbs.

Outside Stringers: To get the maximum live load moment upon the stringer, one rear wheel of roller will come in contact with curb and will be midway between floor beams. Assume entire weight of wheel upon the stringer.

The dead load on stringer will be about $\frac{1}{2}$ that on the intermediate stringer or 6500 lbs.

Weight of stringer (assumed at 31.5 lbs per ft.) = 400 lbs.

Total maximum end shear = $\frac{10000 + 6500 + 400}{2} = 10200$ lbs.

Total maximum moment $12.5 \times 12 \left(\frac{10000}{4} + \frac{6900}{8} \right) = 500,000$ in. lbs.

From Cambria a 12-I weight 31.5 lbs. will carry 570,000 in. lbs.

FLOOR BEAMS:

Intermediate Floor Beams: The maximum live load moment will occur when the 2 adjacent panels are fully loaded with a crowd of people at 100 lbs. per sq. ft. Both the live and dead loads will be concentrated at the points of connection of the stringers to the floor beams.

At connection of intermediate stringers:

live load = $6 \times 12 \times 100 = 7500$ lbs.

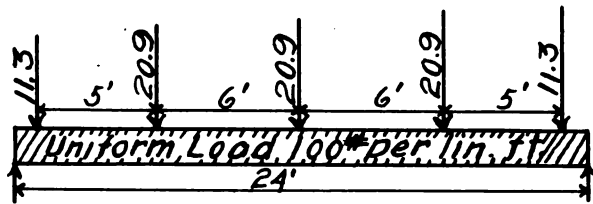
dead load	$\frac{13400}{2}$	"
Total	20,900	"

At connection of outside stringers:

live load = $3.5 \times 12.5 \times 100 = 4400$ lbs.

dead load	$\frac{6900}{2}$	"
Total	11,300	"

The distribution of loads are shown in sketch.



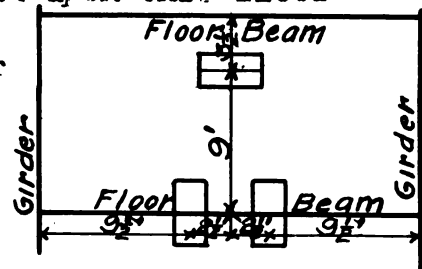
Total maximum end shear (assuming weight of floorbeam at 100 lbs. per ft.) = $\frac{24 \times 100 + 3 \times 20,900 + 2 \times 11,300}{2} = 43,700$ lbs.

Total maximum moment = $43,700 \times 12 - 20,900 \times 6 - 11.3 \times 11 - 1200 \times 6 = 266,000$ ft. lbs.

From Cambria a 24-I weight 100 lbs. will carry 264,400 ft. lbs.

This section may be used, the deficiency being only about .5%.

End Floor Beams: The maximum live load upon this floor beam will occur when the 2 rear roller wheels are upon it and equidistant from its center as shown in sketch.



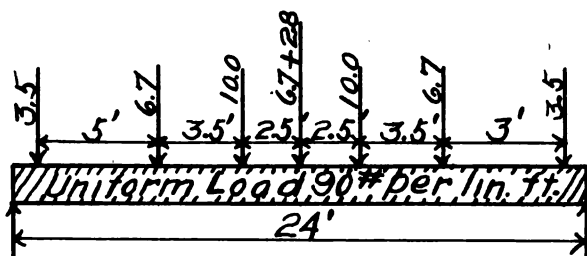
The maximum load upon the floor beam due to the front wheel = $\frac{10000 \times 3.5}{12.5} = 2800$ lbs. and will occur at the center of beam.

The dead loads upon the floor beam will be at the stringer connections.

At intermediate stringers dead load = 6700 lbs.

At outside " " " = 3500 "

The distribution of loads are as shown in sketch:



Total maximum end shear (assuming weight of floor beam at 90 lbs. per ft.) = $\frac{24 \times 90 + 9500 + 2 (3.5 + 6.7 + 10.0) \times 1000}{2} =$
26,000 lbs.

Total maximum moment

$1000 (25.9 \times 12 - 3.5 \times 11 - 6.7 \times 6 - 10 \times 2.5 - 1.1 \times 6) =$
202000 ft. lbs.

From Cambria a 20 in. I-B-121-weight 90 lbs will carry
207,700 ft. lbs.

SIDEWALK.

FLOORING. The maximum live load upon the sidewalk is that due to a crowd of people at 100 lbs. per sq. ft.

In the St. Louis Expanded Metal Co's catalogue it is found that a 3 in. layer of concrete reinforced by a netting with 2.5 in. meshes will support over a span of 5 ft. a load of 960 lbs. per sq. ft. besides its own weight. This will give a factor of safety of 9.6. and will be used.

STRINGERS: Each stringer will carry .5 the load in the panel. Assuming the weight of the walk at 140 lbs. per cu.

ft. and that only $5 \frac{1}{2}$ ft. of walk can carry a live load;

Dead load 12.5 3 .25 140 1300 lbs.

Max. live load 12.5 2.75 100 3430 lbs.

Total 4730 "

Total maximum moment $\frac{4730 \times 12.5 \times 12}{8}$ 89,000 in. lbs.

A Cambria 5 in. I-B wt. 14.75 will carry 97,500 in. lbs.

BRACKETS: The maximum loads on bracket will be those due to: its own weight; max. stringer reactions; and weight of fence.

Weight of Bracket: The bracket will be made up of a web with 2 angles at the top and 2 angles at the bottom which will serve as stiffeners.

Assume depth of bracket next to the girder at 30 in. and 6.5 in. at the end. Thickness of web $\frac{3}{8}$ in. and the angles 3 3 $\frac{5}{16}$.

The volume of the web

$\frac{30 \times 6.5}{2} \times 60 \times \frac{3}{8}$ 410 cu. in. .24 cu. ft.

Weight of web at 490 lbs. per cu. ft. 120 lbs.

Weight of angles at 6.1 lbs. per ft. 160 "

Assume weight of rivets, $\frac{20}{300}$ "

Total 300 "

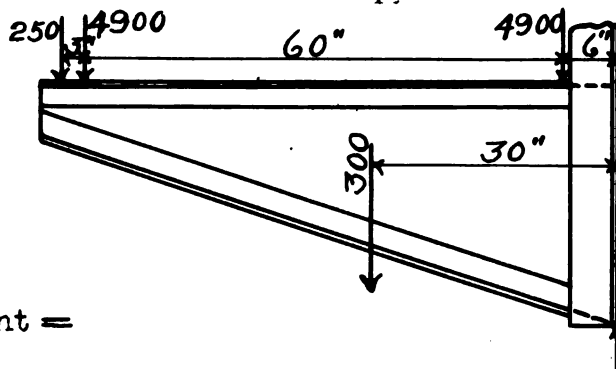
Weight of fence: The piping is 2 in. in diameter and $\frac{1}{4}$ in. thick, weighing 6 lbs. per lineal ft.

Assuming the weight of supports at 30 lbs., the load upon bracket due to weight of fence will be $12.5 \times 3 \times 6 + 30 = 250$ lbs.

Moments: The loads applied at points of connection of stringers will be the sum of the live and dead load carried by the stringer + the weight of stringer itself =

$$4730 + 12.5 \times 14.75 = 4900 \text{ lbs.}$$

The loads upon bracket will be applied as shown below:



Maximum moment =

$$4900 \times (6 + 66) + 300 \times 30 + 250 \times 69 = 380,000 \text{ in. lbs.}$$

Section: The effective depth $= 30.25 - 1.85 = 28.40$

$$\text{Area required for bending moment} = \frac{380,000}{28.4 \times 16000} = .83 \text{ sq. in.}$$

	Gross	Net
Area of $\frac{1}{8}$ web:	$\frac{1}{8} \times 30 \times \frac{3}{8} = 1.4$	1.1

This is more than is necessary. The angles are therefore not necessary but will be used as stiffeners and will be 3 in. 3 in. $\frac{3}{8}$ in.

PLATE GIRDERS.

PANEL LOADS: The live and dead load weights upon the girder will be concentrated at the points of attachment of floor beams and brackets to the girder. The depth of the girder will be assumed at 72.25 in. b. to b. of angles.

The Girder with attached walk will first be considered.

The actual dead and live loads on the walk =

$$2 \times 4900 + 300 + 250 = 10,200 \text{ lbs.}$$

Assuming the center of gravity of these loads

at 3 ft. from the girder, the load exerted on the girder due to eccentricity of the walk will be $\frac{27}{24} 10200 \text{ lbs} = 10500 \text{ lbs.}$

The other loads will be as follows:

Maximum reaction at end of floor beam 43,700 lbs.

Weight of $12\frac{1}{2}$ ft. of girder assumed at 325 lbs.

per foot, 4,100 "

Total maximum dead and live panel load =

$$10,500 + 43,700 + 4400 = 58300 \text{ lbs.}$$

Max. L. panel L. = $12.5 (12 + 5.5) \times 100 = \frac{21800}{36,500}$ "
 " D. panel L. "

MAXIMUM MOMENTS: For max. moments the girder should be fully loaded.

Maximum Moment at center =

$$12.5 \left(\frac{3}{2} \times 58000 \times 2 - 5800 \right) 12 = 17,400,000 \text{ in. lbs.}$$

Maximum Moment at quarter point =

$$12.5 \times \frac{3}{2} \times 58000 \times 12 = 13,000,000 \text{ in. lbs.}$$

MAXIMUM SHEARS: For maximum live load shears in end panels the girder should be fully loaded. For maximum live load shears in center panels, but 2 panels should be loaded.

Maximum Shear in end panel =

$$\frac{3}{2} \times 58000 = 87,000 \text{ lbs.}$$

Maximum L. L. shear in center panel =

$$21300 \left(\frac{1 + 2}{4} \right) = 16000 \text{ lbs.}$$

Maximum D. L. shear =

$$\frac{3}{2} \times 37000 - 37000 = 18,500 \text{ lbs.}$$

Maximum total shear in center panel =

$$18,500 + 16,000 = 34500 \text{ lbs.}$$

THICKNESS OF WEB: The required thickness = the max. end shear divided by : (the allowable shearing stress per sq. in. $\times$ depth of web.) =

$$\frac{37000}{9000 \times 72} = .134$$

A $\frac{3}{8}$ in. web will be used.

FLANGE: The net area required for flange = the max. moment divided (allowable fibre stress $\times$ depth of section) =

$$\frac{17,400,000}{16000 \times 72.25} = 15 \text{ sq. in.}$$

Area of $\frac{1}{8}$ web = 3.4 sq. in.

Required area for flange = 15 - 3.4 = 11.6 sq. in.

2-6" $\times$ 6" $\times$ $\frac{3}{8}$ " angles whose net area is 8.1 sq. in. will be used and the remaining 3.5 sq. in. of flange area will be taken care of by cover plates.

Cover Plate: The cover plates will be made 14 in. wide.

Net width after deducting 1.7 in. for rivet holes is 12.3

Thickness of plate required = $\frac{3.5}{12.3} = .285"$

A $\frac{3}{8}$ in. cover plate will be used.

Redesign of flange: The center of gravity from back of angles:

of cover plate .1875"

" angles 1.64"

The center of gravity of flange from back of angle, the area of the $\angle$ s and cover plate being 8.72 and 4.64 sq. in. respectively, =

$$\frac{1.64 \times 8.72 - .1875 \times 4.64}{8.72 + 4.64} = 1.00$$

Effective depth of girder = 72.25 - 2 = 70.25

$$\text{Total flange area required} = \frac{17,400,000}{16,000 \times 70.25} = 15.5$$

The flange used above gives a greater total area than this and will be used.

Length of Cover Plate: The moment at the quarter point = 13,000,000.

Assuming that no plate is required at this point the effective depth will be 68.97 inches.

$$R. \text{ net } A. = \frac{13,000,000}{16,000 \times 68.97} = 11.7 \text{ sq. in.}$$

The web and angles give a net area of 11.5 sq. in.

The moment at 1 ft. past the quarter point =

$$\frac{11.5}{12.5} \times 13,000,000 = 12,400,000$$

This will require a net area of 11.3 sq. in.

For safety the plate will be extended 2 ft. past the quarter point.

In the upper flange the cover plate will be extended to the end of girder so as to protect it from rain and snow.

End Stiffeners: The end stiffeners will be designed to carry all the end shear. The area required will then be

$$\frac{87,000}{16,000} = 5.5 \text{ sq. in.}$$

The angles used $\left\{ \begin{array}{l} 2-5'' \times 3 \frac{1}{2}'' \times \frac{3}{8}'' \\ 2-6'' \times 6'' \times \frac{3}{8}'' \end{array} \right\}$ will give an area of 14.8 in.

Intermediate Stiffeners: Stiffener angles $3 \frac{1}{2}'' \times 3 \frac{1}{2}'' \times \frac{3}{8}''$ placed on each side of girder (except those at the point of connection of floor beams to the girder where both will be placed on the outside) and will be spaced 4 ft.-2 in. apart. Stiffener angles at the floor beams will be $5'' \times 3 \frac{1}{2}'' \times \frac{3}{8}''$.

Fillerplates will be used under all stiffeners.

Bed Plates: The bed plates will be of such area so as not to exert more than 400 lbs. per sq. in. upon the masonry. The pressure upon them will be equal to the maximum end reaction.

The area required = $\frac{87,000}{400} = 218$ sq. in.

A bed plate 15in. $\times$ 15 in. $\times$ $\frac{1}{2}$ in. will be used. Area = 225

Girder Without Walk. The web in girder designed, as well as angles and stiffeners are of the least permissible width. The depth of 2 girders should be the same. Therefore this girder will be same as other girder except in minor details as shown on drawing.

RIVETS.

$\frac{3}{4}$ in. rivets will be used throughout, the bearing and shearing stresses will be 22,000 and 9000 lbs. respectively.

Flange Angles: The maximum allowable pitch in flange angles will be obtained by substituting values in formula given by Johnson in his Framed Structures.

$$\text{At end P} = \frac{8.1 + 3.4}{8.1} \times \frac{6200 \times 70.25}{87000} = 7.1$$

Two rows of rivets will be used. The pitch will be 4.5 in. up to 2nd stiffeners and 6 in. thereafter.

Floor Beams: The floor beams will be connected to the girders by 2 angles. The number of rivets will be obtained by dividing the maximum end shear in floor beam by 3975

(the shearing values of a $\frac{3}{4}$ in. rivet)

$$\frac{43,700}{3975} = 11 \text{ (shop rivets)}$$

Adding 25% for field riveting will give 14 rivets. There will be 7 in each angle.

$$\frac{43,700}{6200} = 7 \text{ (shop rivets) or 9 field rivets.}$$

For connecting angles to the floor beam 9 rivets will be used.

In the end floor beams it is found that 8 rivets for connecting the beams to girder and 5 rivets for connecting angles to the beam, are required.

Stringers: The stringers will be connected to the floor beams by 2 angles.

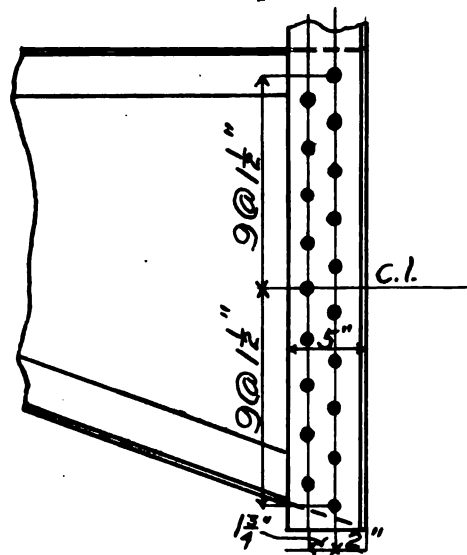
$$\frac{12500}{3975} = 4 \text{ (shop rivets) or 5 field rivets.}$$

In the outside stringers it is found that 4 field rivets are required.

Bracket: At the point where the brackets are to be attached, there are 2 stiffeners placed back to back with an intervening space of $\frac{3}{8}$ in. The web of the bracket will occupy this intervening space and will be riveted to the stiffeners as shown in drawings.

We will first consider the number of rivets required to fasten the bracket to the stiffener.

Assume projecting stiffener leg at 5 in. and insert as many rivets as possible. From standard tables it is found that the least allowable pitch for $\frac{3}{4}$ in. angles in a 5 in. angle leg will be $1 \frac{1}{2}$ in.



Arranging rivets as shown in figure, the total moment that they will bear with a maximum stress of 6200 lbs. on last rivet is found, by taking moments about the center of gravity of the rivets to be:

$$2 \times \frac{3}{2} \times \frac{6200}{9} \quad (9^2 + 8^2 \dots 1) =$$

$$3 \times \frac{6200}{9} \times 285 = 588,000 \text{ in. lbs.}$$

Assuming the strength of field rivets at 75% that of shop rivets, the allowable moment upon rivets will be:

$$.75 \times 588,000 = 440,000 \text{ in. lbs.}$$

The above arrangement of rivets will be used, since the maximum moment to be borne is only 380,000 in. lbs.

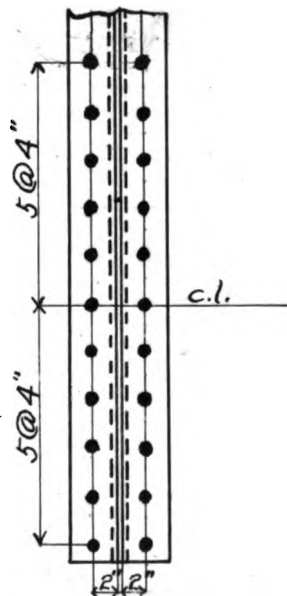
In figuring the rivets connecting the bracket to the girder, 13 in. of stiffener above the bracket will be assumed as part of the bracket.

The rivets will be in tension, and assuming them spaced as in accompanying figure and computing moments as above, it is found that the tension in last rivet is equal to the total moment divided by 176.

$$\frac{380,000}{176} = 2160 \text{ lbs.}$$

This will give a tensile stress of 4,900 per sq. in.

Above arrangement of rivets will be employed.



Estimate.

Bridge Steel, 46,100 lbs. at 5¢	\$2305.00
Steel reinforcing, 5700 lbs. at 5¢	285.00

Concrete, 46 cu. yds. at \$6.00	\$276.00
Asphalt paving 133 sq. yds. at \$3.00	399.00
Plus 15%	<u>490.00</u>
Total	\$3,755.00

Abutments and Retaining Wall.

The approach from West Wilson street to the bridge will be on the east side of the street and to allow for sufficient roadway in front of the property on the opposite side a retaining wall will be connected with the abutment at right angles to it, thus constituting one of its wings.

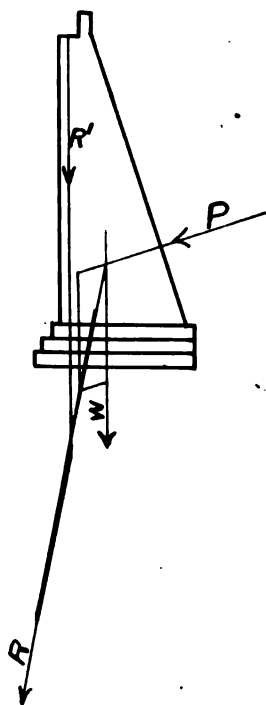
The abutments and retaining wall will be of the gravity type and will be made of a natural cement concrete of a 1-3-6 mixture. (It has been found by experiment that natural cement gives greater strength for a given cost than Portland cement.) The front faces of the abutment, as well as of the wing and retaining walls, will be straight and in order not to intrude upon the railroad's right of way the abutment on the water side will be 33 feet and on the land side 15 feet from the center of the tracks, respectively.

Abutment on Water Side.

The height of the parapet, to conform with the height of the bridge floor above the bed-plates, will be 2' 9". The thickness will be 1.5 feet. The length of the top will be 30 feet, this being the width of the roadway.

The length of the bottom will be 30 feet plus the amount due to the two to one slope of the earth which will give a total width of 41 feet.

In order to get the required clearance of 22 feet above the base of rails it is found from the profile that the bridge seat should be 29'-6" above the ground line. Adding 9" for the distance of ground line above the base will give a height of 30' 3". The width of the base will be figured as 0.4 of the height of the wall.



By a graphical solution of resolving the forces due to the weight of masonry; the earth pressure; and the reaction due to the bridge loading, it is found that three 18 inch footing courses arranged as shown in figure, will bring the resultant pressure within the middle third and will exert, upon the foundation, a maximum pressure just within 3 ton per square foot.

In the above figure P is the pressure of the earth which is assumed as acting normal to the back wall, w is the weight of masonry, R' is the reaction due to the bridge loading,

and R is the resultant of all the forces.

The wing walls will be of the straight type, with a top width of 1.5 feet and a width at the bottom equal to 0.4 of the height. They, as well as the bridge seat, will be finished with a coping 18 inches deep and projecting 3 inches from the face of the wall.

The bridge seat will be made 2 ft. wide, this allowing a clearance of 4.5 in. on each side of the bed-plate.

COMPUTATIONS.

The area of cross-section through the abutment is found to be 338.5 sq. ft. Multiplying this by the length, 41 ft. and deducting for the slope of the parapet wall gives 13,870 cu. ft. for the volume of abutment.

The wing walls will extend from the abutment with a top slope of 2 to 1 until a height of 7 ft. is reached. They will have two footing courses up to a point fifteen ft. from the abutment, thereafter there will be but one course.

$$\text{Length of wing wall} = 2 \times 31.75 - 2 \times 7 = 49.5 \text{ ft.}$$

In computing the volume of the wing wall we will first consider the first fifteen feet from the abutment.

Width of base of section at abutment = $.4 \times 30.25 = 12.1$

Area of section = 249.5 sq. ft.

Batter of inside face = $\frac{10.6}{30.25} = \frac{1}{2.85}$



Width of base of end section $1.5 \quad \frac{22.75}{2.85} \quad 9.5$

Area of section 161.1 sq. ft.



Width of base of middle section

$\frac{12.1 \quad 9.5}{2} \quad 10.8$

Area of section 202.9



Volume by prismoidal formula 3,055 cu. ft.

Remaining 34.5 feet of wing wall.

Width of base of end section

$1.5 \quad \frac{5.5}{2.85} \quad 3.4$

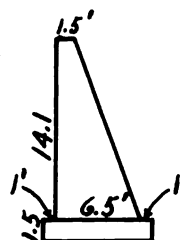


Area of section 21.6 sq. ft.

Width of base of middle section

$\frac{9.5 \quad 3.4}{2} \quad 6.5$

Area of section 69.1 sq. ft.



Area of other end section 42.3 sq. ft.

Volume of wing 1,957 cu. ft.

Total volume of abutment and two wing walls

23,894 cu. ft.

ABUTMENT ON LAND SIDE.

The parapet wall with exception of the bottom length will be similar to that of the opposite abutment. The retaining wall will be connected to the west side of the abutment, and this will dispense with the necessity of increasing the length of this side of the abutment so as to conform with the slope of the earth. The increase in length will be 1.5 feet, which is the top width of the retaining wall. This will give a length of abutment of thirty seven feet.

In order to get the required clearance, it is found from the profile that the bridge seat should be 20 feet 3 inches above the ground line. Adding 9 inches for distance of ground line above base, will give a height of 21 feet.

By a graphical solution it was found that a section with base equal to .4 the height and an 18 inch footing, projecting 1 foot on both sides, will bring the resultant pressure within the middle third and will give a maximum pressure of 2.5 tons per sq. ft.

The wing wall (with exception of length and footing) and bridge seat will in all respects be similar to those of the other abutment.

COMPUTATIONS.

Area of section through abutment is found to be 168.3 feet. Volume of abutment = 6,216 cu. ft.

There will be but one footing course throughout length of the wing wall. Length of wing wall = $2 \times 22.5 - 2 \times 7 = 31$ feet.

Width of base at abutment $.4 \times 21 = 8.4$.

It will be made 8.5.

Area of section = 120.8 sq. ft.

Batter on inside = $\frac{2}{21} = \frac{1}{3}$

Width of base of end section =

1.5 $\frac{5.5}{3}$ 3.3

Area of section = 18.2 sq. ft.

Width of base of middle section =

$\frac{8.5 + 3.3}{2} = 5.9$

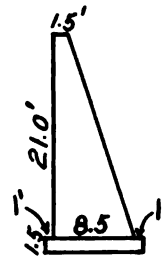
Area of section = 60.9 sq. ft.

Volume of wing = 1,975 cu. ft.

Total volume of abutment and wing = 9,191 cu. ft.

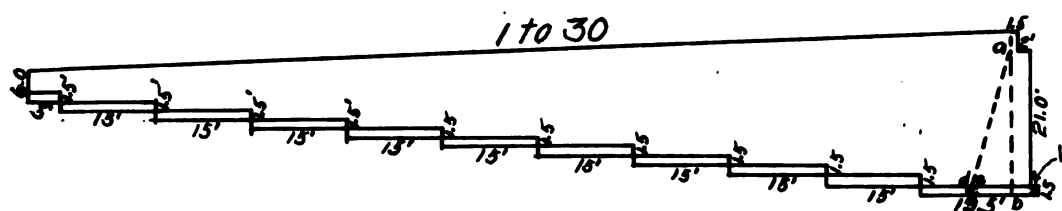
RETAINING WALL.

The grade of the approach is 3.3% and the slope of



the ground is found from the profile to be about 1 to 10. To conform to these the slope of the top of the wall will be 1 to 30 and of the bottom 1 to 10.

The base of a structure is never built on a slope therefor it will be necessary to take offset. The offsets will be taken at 18 in. With these offsets and slope of 1 to 10 it will be most economical to take these offsets every 15 feet. Below is shown a longitudinal section through the wall.



The wall will be continued until a height of 6 feet is reached. The footing will be 18 inches thick with a 1 foot offset. The coping will be 18 inches deep and will project 3 inches from face of wall.

COMPUTATIONS.

Taking the last portion 5 ft. long the length of wall is 155 ft.

Section at abutment 148 sq. ft.

$$\text{Batter of inside face} = \frac{8}{23.8} = \frac{1}{3}$$

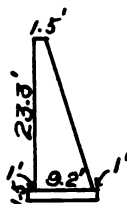


Height of end section =

$$23.8 - \frac{15}{30} = 23.3$$

$$\text{Width} = 1.5 + \frac{23.3}{3} = 9.2$$

Area of section = 141.5 sq. ft.



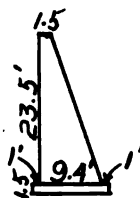
Height of middle section =

$$\frac{23.8 + 23.3}{2} = 23.5$$

Width of base =

$$\frac{9.5 + 9.2}{2} = 9.4$$

Area of section = 146.1 sq. ft.



Volume = 2184.7 cu. ft.

Deducting volume of wedge (a-b-c-d-e in above figure) already figured in abutment,, the volume = 1890 cu. ft.

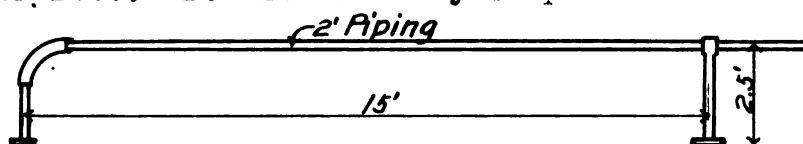
By a similar method of computation, the volume of the remaining portion of the wall is found to be as follows:

2nd - 15 ft.	1890 cu. ft.
3rd - " "	1709 " "
4th - " "	1387 " "
5th - " "	1146 " "
6th - " "	941 " "
7th - " "	765 " "
8th - " "	588 " "

9th - 15 ft.	447 cu. ft.
10th - " "	223 " "
Last - 5 "	<u>88 " "</u>
	9184
1st, portion	<u>1890</u>
Volume of Wall	11,074

Total volume of concrete in abutments wing and retaining walls = 1598 cu. yds.

On top of the retaining wall will be placed a rail fence 2.5 feet high, made of 2-inch gas piping supported every 15 feet. It will be very simple as shown below:



Estimated weight at 6 lbs. per lineal foot of pipe =
850 lbs.

Estimate.

Concrete, 1598 cu. yds. at \$4.00	6392.00
Bracing, sheeting, scaffolding etc. at	
\$24.00 per thousand B. M.	1356.00
Iron Fence: 850 lbs. at 5¢	43.00
Plus 15%	<u>1169.00</u>
	\$8960.00

DRIVE.

The drive will extend as shown in accompanying map from the intersection of Washington Ave., and Murray St., to intersection of West Wilson and Bassett streets. In order to provide against high water the top surface of drive will at no place (with exception of subway) be less than 2 ft. above the datum plane. It is found necessary, in order to get the required head room, to have the floor of subway 6.8 feet below datum; and in order to get the required clearance over the C. M. & St. P. R. R. tracks, the elevation of the bridge floor must be 30.3 ft. above the datum. These considerations will determine the profile of the proposed drive, drawings of which together with present profile are hereto annexed.

To conform to the roads to which it is connected, the drive will be made of broken stone.

The material upon which this drive is to be built will be a mixture of sand and gravel, dredged from the lake bottom. This usually drains very easily, but to be on the safe side we will assume that it is retentive of moisture and will be hard to drain. In such a case the soil will

work up into the stone and the road metal will work down into the soil. This difficulty can be obviated by the use of a Telford foundation.

DESIGN.

The design of road as shown upon accompanying drawings will be as follows:

The subgrade will first be made to conform to the finished grade of drive. The stone foundation 9 feet in width will be placed in the center of the road. This foundation will consist of large stones laid on edge, lengthwise of drive with narrow side down, and will be 6 inches high.

Upon this foundation will then be placed a 3 inch layer of crushed stone (the pieces of which shall be 1.5 to 2 inches in diameter) which will be thoroughly rolled by a steam roller. After this layer becomes firm another one 3 inches thick will be added, the interspaces filled with screenings, and then it will be thoroughly rolled. These layers will overlap the foundation 2.5 feet on each side, forming wings. The width of driveway will be 30 feet from out to out of shoulders, the latter being of gravel and 8 feet wide.

A tile drain will be placed 2 feet under edge of

pavement on water side of drive.

Total length of drive, including bridge and subway=
4400 feet.

Estimate.

Telford Road, 6500 sq. yds, at \$1.50 \$9750.00

Tile Drain, (5 in.)
4200 ft. at \$20.00 per M. 84.00

Plus 15% 1475.00
Total 11,309.00

EARTHWORK.

The amount of fill required will be that necessary for building the embankment for the drive with a 2 to 1 slope plus that required for filling in that portion of the lake between the drive on the west side of the subway, and the lake shore. The latter fill will be brought up to the level of the road-bed and will comprise the land to be converted into lots. The Park and Pleasure Drive Association will rent the hydraulic dredge which has been in use in the southeastern part of Madison, with which it is estimated that it can dredge at 12¢ per cu. yd. (including the rent of the dredge cost of fuel and wages of the men).

The volume of this fill was obtained by drawing upon cross-section paper cross-sections of every 100 feet. The horizontal and vertical scales were taken alike and the area of each section was then obtained by means of a planimeter. The volume of each 100 feet was then obtained by the method of averaging end areas.

The total volume of fill was computed to be 295,705 cu. yds.

Estimate.

Fill- 295,705 cu. yds. at 12¢	\$35,484.00
-------------------------------	-------------

Total Estimate of Project.

Subway	\$12,920.00
Overhead Crossing	3,755.00
Abutments and Retaining Wall	8,960.00
Drive	11,309.00
Fill	<u>35,484.00</u>
Grand Total	72,428.00

Probable receipts from lots:

68 fifty ft. lots at \$25.00 per ft.	\$85,000.00
Amount of money left for park purposes,	12,572.00
Interest charges on investment at 5%,	3,621.40

This will necessitate the sale of three lots
per year.

ADVERTISEMENT.

Construction of Concrete Steel Subway.

Office of Madison, Wis., May ..., 1905,

Sealed proposals will be received at this office until 2 o'clock, P.M., of Saturday, ..., for excavating, furnishing material and building a concrete steel subway underneath the Chicago, Milwaukee, and St. Paul R.R. tracks at the triangle south of the West Madison station. Plans, specifications, forms of proposals and other information may be obtained on application to the undersigned. The right is reserved to reject any and all bids and to waive defects.

.....

Engineer in Charge.

Madison, Wis.

ADVERTISEMENT.

Plate Girder Bridge.

Office of Madison, Wis., May..., 1905,

Sealed proposals will be received at this office until 2 o'clock, P.M., of Saturday, ...(for furnishing material, building and erecting a plate girder bridge over the Chicago, Milwaukee and St. Paul R. R. tracks at the foot of Bassett St., at Madison, Wis. Plans, specifications forms of proposals and other information may be obtained on application to the undersigned. The right is reserved to reject any and all bids and to waive defects.

.....

Engineer in Charge.

Madison, Wis.

ADVERTISEMENT.

Abutments and Retaining Wall.

Office of Madison, Wis., May..., 1905,
Sealed proposals will be received at this office until 2 o-
clock, P.M., of Saturday, ... (for excavating
furnishing material and building two concrete bridge
abutments and a retaining wall at the foot of Bassett St.,
at Madison, Wis. Plans, specifications, forms of pro-
posals and other information may be obtained on application
to the undersigned. The right is reserved to reject any
and all bids and to waive defects.

.....

Engineer in Charge.

Madison, Wis.

ADVERTISEMENT.

Telford Road.

Office of Madison, Wis., May..., 1905,
Sealed proposals will be received at this office until 2 o-
clock, P.M., of Saturday, ... (for construction
of a Telford road from intersection of W. Washington Ave.,
and Murray St. to the intersection of Bassett and W. Wilson
St. at Madison, Wis. Plans, specifications, forms of
proposals and other information may be obtained on application
to the undersigned. The right is reserved to reject any
and all bids and to waive defects.

.....

Engineer in Charge.

Madison, Wis.

NOTICE TO CONTRACTORS.

Sealed proposals for

 in the City of Madison, Wis., in accordance with
 the contract and specifications contained herewith, will
 be received at the until 2:30 P.M., Saturday, ..
, and will at that time and place be publicly
 opened and read.

Each bidder is requested to state in
 his proposal his name and place of residence, names of all
 persons interested with him, and also that it is made with-
 out any connections with any other person making any bid
 for the above work.

The plans are on file at

The work to be done consists of

.....
 according to the dimensions
 shown on plans.

All proposals must be made on a blank
 form here-

to annexed. Proposals shall cover the cost of all material, labor and royalty on patents, incidental to the completion of the work with full conformity to the plans and specifications, and with such detailed plans as shall be made by the Engineer or drawn by the Contractor and approved by the Engineer. Prices shall be stated in figures and in writing.

Each proposal shall be accompanied by a certified check to the order of for the sum of 5% of the proposal, which same amount shall be forfeited should the bidder or bidders to whom the contract is awarded refuse or neglect, within ten days after due notice of the award of the contract had been given, to execute the contract, that the may deduct from said money the difference between his or their bids who shall actually enter into the contract to do the prescribed work with such extra cost entailed by printing and advertising as such refusal may make necessary. Such checks shall be returned to the unsuccessful bidders after the award of contract has been made.

The bidder shall state the number of working days required to finish the work. Sundays and legal holi-

days shall not be considered working days. The work contemplated by this improvement shall be completed on or before the

If the proposal or contract is signed by another the former must file with his signature legal evidence of his authority to do so. If a person signs for a corporation he must present legal evidence that he has a rightful authority to such signature, that the signature is binding upon the corporation and that the corporation has legal existence.

A bond of \$..... will be required to insure the faithful performance of the contract and payment of all indebtedness on account of material furnished, labor performed, or fees for any purpose whatsoever. .

The form of proposal, specifications, contract and bond will be found in the following pages.

The reserves the right to reject any and all proposals and reserves the right to award the contract as it deems best for the interests of

Signed. (.....
(.....
(.....

PROPOSAL.

Madison, Wis., ...1905.

To the

.....

Gentlemen:-

The undersigned (hereafter called the contractor) hereby declares that his bid is made in good faith, free from fraud, free from connection with any other persons bidding on the same work, that the only persons interested are those named below, that the locality where the work is to be done has been duly examined, that the contract and specifications accompanying this proposal have been carefully read and that the plans referred to have been carefully studied. He hereby bids in accordance with the notice to contractors to provide all necessary machinery, tools, apparatus and other means of construction, pay all labor, do all work, and pay royalties on patent rods which shall be used as shown in general plans furnished or such detailed plans prepared by the engineer as provided in the specifications. The contractor declares that he will complete the work on or before the day mentioned in the contract and within the number of days, herein provided, for

the following amounts, namely,

Item (a) For constructing

 as shown in the plans and designated in the specifications;
 to complete the work in full the sum of
 dollars, (\$.....) and cents.

Item (b) For all extra work as shall be ordered by
 the Engineer in writing and approved by
 such a price will be paid as will justly pay for the
 material and allow 10% additional for the Contractor. Said
 cost shall not include any charge for the use of tools or
 time spent by the Contractor.

The undersigned will commence work within ten
 days after signing the contracts unless a further delay be
 authorized by those letting the contract, will finish pre-
 viously described work on, 1905, requir-
 ing for the execution of the same working days.

The above shall be payable out of the
 fund raised to defray the expenses of said
 work and hereby agree to enter into this contract
 within ten days of the acceptance of this proposal, to

finish and complete the work according to the above described conditions and will furnish such surety as the shall see fit.

Should, on part, default any of these conditions, the deposit herewith enclosed shall be forfeited to of Madison, Wis., subject to the conditions stated in the notice to contractors accompanying this proposal.

Signed. (.....
(.....
(.....

Parties in-
terested in Signed. (.....
Bids. (.....

Name of
Surety Co. Signed.

ARTICLE OF AGREEMENT.

Article of agreement made and entered into this
 day of 19 between the Park and Pleasure
 Drive Association of Madison, Wis., party of the first part
 and hereinafter called the Association, and
 county of, state of
 party of the second part, hereinafter called the Contractor,

WITNESSETH, that the parties to these presents, each in
 consideration of the covenants and agreements on the part of
 the other, herein contained, have covenanted and agreed and
 do hereby covenant and agree, the party of the first part
 for itself and the party of the second part for
 and heirs, executors, administrators and assigns, and under
 the penalties expressed in bonds bearing even date with
 these presents and hereunto annexed, as follows;

.....

General Specifications.

CONTRACTOR. The Contractor shall be the person or persons undertaking the work under these specifications and drawings.

ENGINEER. The word Engineer signifies the person employed by the Madison Park and Pleasure Drive Association to see that the work is performed according to specifications and make estimates of the work performed. In case of doubt as to the meaning or intent of plans or specifications the Engineer's interpretation of the same shall be final and without appeal.

PLANS. Plans will be considered part of the specifications and the right is reserved to make such changes as the work may necessitate and such price shall be paid for the same as is given in the proposal. On all drawings, figured dimensions are to govern in cases of discrepancy between scale and figures.

SUB-CONTRACTORS. The work shall not be sub-let.

ABANDONMENT OF CONTRACT. Should the contract be abandoned the Association reserves the right to use all tools, appliances, materials and machinery belonging to the Contractor that may be on the work.

SUPERVISION. The Contractor shall give the work his personal attention and should provide a capable foreman when absent.

SURVEYS AND MEASUREMENTS. These shall be made and given by the Engineer, after which the Contractor is held liable for any errors which may occur due to any obliterations or changes in same.

MANNER OF EXECUTING WORK. The work should be executed in the most workmanlike and substantial manner, all material used shall be first class and subject to the approval of the Engineer.

REMOVING INCOMPETENT MEN. The Engineer will have the right to require the removal of any workman or workmen if in his judgment it shall be for the best interest of the work.

WORK TO BE COMPLETE. The Contractor shall furnish all material and labor, falsework, tools and appliances necessary to complete the work as designed.

PROTECTION OF FINISHED WORK. All work should be perfect at completion, and must be protected by the Contractor until that time.

CLEANING UP. Before the work will be considered complete all rubbish and unused material due to or connected with

construction must be removed and the premises left in the condition satisfactory to the Engineer.

STORING MATERIAL. The Contractor must at his own expense and risk obtain all rights and privileges for setting up derricks, tools, etc., and storing material on foreign property.

LAWS AND ORDINANCES. The Contractor will comply with all corporation ordinances and regulations and pay all charges of every kind, permits, use of water, etc.

PROTECTION OF PROPERTY. The Contractor must provide all requisites for the protection of his work, subject to the order of the Engineer. The work is entirely at the Contractor's risk until the same is approved and accepted; and should any damages or injuries occur to any property or persons before same is approved and accepted, the Contractor will be entirely responsible.

PATENTS. The Contractor shall pay royalties upon all patent articles used upon the work.

BOND. The Contractor will be required to give bond to the amount of one-fourth the contract price, for the faithful performance of the work. The bond shall be executed jointly and severally by two resident property owners, each

finish and complete the work according to the above described conditions and will furnish such surety as the shall see fit.

Should, on part, default any of these conditions, the deposit herewith enclosed shall be forfeited to of Madison, Wis., subject to the conditions stated in the notice to contractors accompanying this proposal.

Signed. (.....
(.....
(.....

Parties in-
terested in Signed. (.....
Bids. (.....
(.....

Name of
Surety Co. Signed.

ARTICLE OF AGREEMENT.

Article of agreement made and entered into this
 day of 19 between the Park and Pleasure
 Drive Association of Madison, Wis., party of the first part
 and hereinafter called the Association, and
 county of, state of
 party of the second part, hereinafter called the Contractor,

WITNESSETH, that the parties to these presents, each in
 consideration of the covenants and agreements on the part of
 the other, herein contained, have covenanted and agreed and
 do hereby covenant and agree, the party of the first part
 for itself and the party of the second part for
 and heirs, executors, administrators and assigns, and under
 the penalties expressed in bonds bearing even date with
 these presents and hereunto annexed, as follows;

.....

General Specifications.

CONTRACTOR. The Contractor shall be the person or persons undertaking the work under these specifications and drawings.

ENGINEER. The word Engineer signifies the person employed by the Madison Park and Pleasure Drive Association to see that the work is performed according to specifications and make estimates of the work performed. In case of doubt as to the meaning or intent of plans or specifications the Engineer's interpretation of the same shall be final and without appeal.

PLANS. Plans will be considered part of the specifications and the right is reserved to make such changes as the work may necessitate and such price shall be paid for the same as is given in the proposal. On all drawings, figured dimensions are to govern in cases of discrepancy between scale and figures.

SUB-CONTRACTORS. The work shall not be sub-let.

ABANDONMENT OF CONTRACT. Should the contract be abandoned the Association reserves the right to use all tools, appliances, materials and machinery belonging to the Contractor that may be on the work.

SUPERVISION. The Contractor shall give the work his personal attention and should provide a capable foreman when absent.

SURVEYS AND MEASUREMENTS. These shall be made and given by the Engineer, after which the Contractor is held liable for any errors which may occur due to any obliterations or changes in same.

MANNER OF EXECUTING WORK. The work should be executed in the most workmanlike and substantial manner, all material used shall be first class and subject to the approval of the Engineer.

REMOVING INCOMPETENT MEN. The Engineer will have the right to require the removal of any workman or workmen if in his judgment it shall be for the best interest of the work.

WORK TO BE COMPLETE. The Contractor shall furnish all material and labor, falsework, tools and appliances necessary to complete the work as designed.

PROTECTION OF FINISHED WORK. All work should be perfect at completion, and must be protected by the Contractor until that time.

CLEANING UP. Before the work will be considered complete all rubbish and unused material due to or connected with

construction must be removed and the premises left in the condition satisfactory to the Engineer.

STORING MATERIAL. The Contractor must at his own expense and risk obtain all rights and privileges for setting up derricks, tools, etc., and storing material on foreign property.

LAWS AND ORDINANCES. The Contractor will comply with all corporation ordinances and regulations and pay all charges of every kind, permits, use of water, etc.

PROTECTION OF PROPERTY. The Contractor must provide all requisites for the protection of his work, subject to the order of the Engineer. The work is entirely at the Contractor's risk until the same is approved and accepted; and should any damages or injuries occur to any property or persons before same is approved and accepted, the Contractor will be entirely responsible.

PATENTS. The Contractor shall pay royalties upon all patent articles used upon the work.

BOND. The Contractor will be required to give bond to the amount of one-fourth the contract price, for the faithful performance of the work. The bond shall be executed jointly and severally by two resident property owners, each

worth at least twice the amount of the bond. The Contractor will be a party to the bond. The bond of an approved surety company will be accepted in lieu of the two bondsmen above mentioned.

PAYMENTS. Monthly payments will be made to the Contractor in a sum of not more than eighty (80) per cent. of the amount then due, the amount due to be decided by the Engineer. The remaining twenty (20) per cent. will be paid upon acceptance and approval of work.

TIME OF COMPLETION. The work shall be commenced within thirty (30) days from the time of awarding the contract and shall be completed on or before

If the work shall not be completed at the time fixed therefor, liquidated damages of dollars per day for each and every day the completion of the work is delayed beyond the date fixed may be charged to the Contractor and deducted from the contract price.

DELAYS. No charge made by the Contractor for any delays or hindrances from any cause during the progress of any portion of the work embraced in the contract will be allowed. If the delay be caused by any act of the Engineer, then the Contractor will be allowed an extension of time

sufficient to compensate for the delay.

AMOUNT OF BID. Each bidder must state in his proposal both in writing and figures the sum of money for which he will perform the work required by the drawings and specifications. He must sign his name in full, give the names of his bondsmen and give his and their addresses.

BIDS. Bids must be made out upon blanks furnished by the Engineer. The Association reserves the right to reject any or all bids.

Form B.

Specifications for Concrete Masonry.

Two grades of concrete masonry will be constructed,- class A and class B.

Class A will be composed of one part Portland cement, two parts sand and three and one-half parts broken stone. This class will be used for construction of subway.

Class B will be composed of one part Rosendale natural cement, two parts sand and six parts stone. This class will be used for abutments and retaining walls. No cement will be allowed to be used except established brands of high grade cement which have been in successful use under similar conditions to those of the proposed work for at least two years.

MEASURING. The cement shall be measured in the exact proportions, the volume, as received in the packed condition, having been first determined by weight. No fluffing of the same shall be allowed. The sand and broken stone shall also be measured by volume. Only a standard sheet-iron wheel barrow will be allowed to be used.

SAND. The sand shall be clean, hard, sharp, and free from loam, clay or other objectionable features.

STONE. The broken stone shall be hard, clean limestone, free from earthy or clayey matter or rotten stone. The largest particle shall not exceed one and one-half inches in the longest dimension. Screenings must not exceed one-sixth of the whole by volume and be reasonably free from dust.

WATER. If necessary to render the sand, stone, and screenings clean, they may be washed as directed by the Engineer.

CEMENT. The cement shall be seasoned or thoroughly aerated at least thirty (30) days before leaving the factory. All cement shall be free from lumps and dry and shall be stored in a dry, well ventilated and well covered shed. The Engineer in charge shall be given due notice of the arrival of each car load so that due examination can be made of the cement. If required the Contractor shall furnish a certified statement of the chemical composition of the cement and the raw material from which it is made.

WEIGHT. The average weight per barrel of Portland shall not be less than 375 pounds net; of natural cement not less than 300 pounds net. If the weight is found to be less than above figures, the cement may be rejected or at the

option of the Engineer, the Contractor may be required to supply free of price, an additional amount of cement equal to the shortage.

CEMENT TESTS. Cement should stand the following tests;

1. **Fineness:** Portland cement,- not less than 92%, by weight, shall pass through a No. 100 sieve (10,000 meshes per square inch). Natural cement,- not less than 80% shall pass through a No. 100 sieve.

2. **Time of setting:** Portland cement,- the initial set shall not occur in less than 30 minutes and must set hard in not less than one hour nor more than ten hours. Natural cement,- the initial set shall not occur in less than twenty minutes and must set hard within four hours.

3. **Tensile strength:** Briquettes shall develop the following tensile strength per square inch, after being kept in air under a wet cloth for twenty-four hours and in water the balance of the time:

Tensile Strength in Pounds.

Age.	Portland.		Natural.	
	Neat.	1 C: 3 S	Neat.	1 C: 2 S
24 hrs.	75		50	
7 days.	500	175	90	25
28 days	600	200	200	75

4. **Specific Gravity:** When thoroughly dried at 100 degrees C. the specific gravity of the Portland cement shall be 3.10.

5. **Constancy of Volume:** Pats of neat Portland cement about three inches in diameter, one-half inch thick at the center and tapering to a thin edge, shall be kept in moist air for a period of twenty-four hours.

a. One pat shall be kept in air at normal temperature and observed at intervals for at least twenty-eight days.

b. Another pat shall be kept in water maintained at 70 degrees Fahr. and observed at intervals for at least twenty-eight days.

c. A third pat shall be exposed in any convenient way to an atmosphere of steam, above boiling water, in a loosely covered vessel for three hours.

In all three instances, the pat should remain firm and hard, and should show no signs of distortion, checking, or disintegration.

FORMS Substantial and unyielding forms shall be erected of suitable dimensions for the proposed work. These shall be securely braced so as to prevent bulging. Only plank matched and dressed to uniform thickness shall be used.

The inside of the forms shall be well planed, chalked and nail holes filled with plaster of Paris. The forms shall be well wetted before the concrete is deposited.

MIXING. The concrete may be mixed by hand or by machines of approved kind and for which the proportions of batch have been accurately measured. No more water than the concrete will bear without quaking when rammed shall be used.

1. Machine mixing: the ingredients shall be so placed in the mixing machine and in such order and condition that experiment shall prove best in the judgment of the Engineer.

2. Hand mixing: a suitable level platform shall be provided on which the sand and cement can be evenly spread. The sand and cement shall then be thoroughly mixed with hoes and shovels until the mass is of uniform color. Water shall then be added in sufficient quantity so that the mortar will fall to the platform from a shovel in a lump. To this mortar shall then be added the broken stone, thoroughly wet, and the whole mass shall be thoroughly mixed until each particle of stone is completely covered with mortar. Shovellers shall leave a clear space between piles.

PLACING OF CONCRETE. If water washes or collects in excavations it shall be removed before placing any concrete

therein. The mixing must be done as rapidly as possible, transported from the mixing platform to the work, deposited and immediately rammed into place. Concrete not rammed into place before setting shall not be retempered but shall be entirely rejected from the work. No concrete shall be dropped into place from an elevation exceeding six feet. The concrete shall be spread in layers not exceeding eight inches in thickness and thoroughly rammed with rammers to the satisfaction of the Engineer. After ramming the concrete shall form a compact, dense, impervious artificial stone, filling all voids so that the mortar comes to the surface showing a perfectly smooth face. Walking shall not be permitted on the concrete after the initial set until it has set permanently.

FACING. A spade facing will be used. The coarse stone will be carefully worked back from the form with a spade so as to bring the excess mortar of the concrete to the face. For the back of abutments and retaining walls the concrete may be simply cast forcibly against the forms, thus working the finer portions of the mixture against the casing and then thoroughly tamping it.

FALSEWORK. The Contractor will be required to furnish

all plank timber, braces, etc., required in construction of the forms, for which no allowance will be made, nor for any scaffolding or other timber used in construction, the cost of all such material being included in contract price per cubic foot of completed work.

EXCAVATIONS. The Contractor shall make all the excavations necessary in such manner and to such depths as will give ample room for holding the structures they are to contain and for facing, supporting, pumping, draining and removing from such excavation all the material the Engineer may deem proper. All surplus excavated material shall be deposited along the proposed drive where directed.

BACK FILLING. The back filling shall be put in place by the Contractor and rammed into place so as to prevent any caving in of the soil. The back filling shall be brought to within two inches of the top of the wing and retaining walls.

FOUNDATIONS. All foundations after excavation must be examined and approved by the Engineer.

COMPLETED STRUCTURE. The completed structure shall be free from all stains left by water which has run down the sides during construction and all walls when finished shall present a smooth uniform surface of cement mortar free from

marks left by the forms or holes caused by the facing having fallen out.

Subway Specifications.

See Forms A and B.

MATERIAL. The subway will be constructed of reenforced concrete and steel as specified in the design and plans.

CONCRETE. The concrete will be composed of one part Portland cement, two parts sand and 3.5 parts broken stone.

STEEL. No reliance will be placed upon the concrete to take tension. St. Louis Expanded Metal shall be used for this purpose. All steel shall be free from paint and oil and all scale or rust must be removed before imbedding in the concrete. A wet mortar of fine concrete shall in all cases be placed adjacent to the metal reenforcement to insure a good bond.

QUALITY OF STEEL. The tensile strength, limit of elasticity and ductility shall be determined from a test piece cut from the finished material and turned and planed parallel. The area of cross-section shall not be less than 0.5 square inches; the elongation shall be measured for an original length of eight inches. Each melt shall be tested for tension and bending. Either soft or medium steel may be used, same to have an ultimate strength of from 54,000 to 62,000 pounds per square inch and an elastic

limit of not less than one-half the ultimate strength. It shall not elongate more than 25% and shall when cold bend flat upon itself.

EXPANSION JOINTS. Expansion joints shall be left in the railing every five or six feet.

ARTIFICIAL STONE. All posts, panels, railings and other ornamental work when used shall be made of the design shown in the plans and be molded in smooth well-chalked suitable molds. When curved surfaces, sharp corners and other delicate work is encountered the molds shall first be plastered with an earth damp mortar composed of 1 part cement and 2.5 parts fine sand.

FACING. The facing shall not be applied on the outside after the concrete has set but shall be applied as specified in clause on artificial stone.

DRAINAGE. The Contractor shall furnish sufficient pumping plant and provide drainage satisfactory to the Engineer. Water shall not be allowed to rise in any part of the masonry or concrete until the mortar has set at least ten hours and the coating of asphalt and naphtha applied.

I BEAMS. The I beams shall be of medium steel and shall have an ultimate strength of from 60,000 to

70,000 pounds per square inch, elastic limit not less than one-half the ultimate strength, elongation 22% in eight inches, and shall bend 180 degrees to a diameter equal to the thickness of the piece tested without fracture of the outside of the bent portion. All I beams not imbedded in concrete shall be thoroughly cleaned of loose scale or rust and painted with a good quality of iron ore paint mixed with pure linseed oil. After being put in place it shall be painted with two additional coats.

COMPLETED STRUCTURE. All parts of the structure above the surface of the ground shall be free from all stains and marks. Below the high water line (elevation 2.1 feet above city datum) the face, after being finished by a coating of earth damp mortar shall be coated with water-proofing. This water-proofing shall consist of a coat of asphalt cut with naphtha to be applied after the concrete is perfectly dry, after which an asphaltic mastic composed of one part asphalt and four parts sand is to be applied. This is to be smoothed off with hot smoothing irons and thoroughly tamped and pressed into place. Before the contract will be considered complete, due examination and

trial must show that the drainage pit and apparatus for removing the surface waters from same shall be in working order and efficient.

ASPHALT. The asphalt shall be free from coal tar or any of its products. It shall not volatilize more than one-half of one per cent, under a temperature of 300 Fahr. for a period of ten hours. It shall not be affected by a solution of ammonia, a 35% solution of hydrochloric acid, a 25% solution of sulphuric acid, or a saturated solution of sodium chloride. The asphalt shall be heated in a suitable kettle to a temperature not exceeding 450 degrees Fahr. until cooked. If pitching occurs (when a bluish tinged vapor comes off) the mixture shall be tempered by an addition of fresh asphalt. The asphalt will be considered cooked when a piece of wood can be thrust into the mixture and removed without the asphalt clinging to same.

Specifications for Over-head Crossing Plate Girder Bridge.

See Form A.

MATERIAL. With the exception of flooring, wheel-guards, hand rails, and rivets, the material shall be of rolled medium steel.

FLOOR BEAMS. Floor beams shall be riveted to the web of girders, so that the bottom surface of floor beams shall be one-eighth inch above the vertical leg of flange angle.

STRINGERS. Stringers shall be riveted to the web of floor beams so as to have the top surface of stringer eight and one-half inches below top surface of floor beams.

WHEEL GUARDS. Wheel guards shall be provided on each side of roadway. The section shall be six by four inches and they shall be a continuation of the concrete crowning. They shall also serve as curb.

FLOOR. The floor shall consist of concrete steel cross beams twenty-four inches by eight and one-half inches placed in contact with one another so as to form a solid flooring. This flooring will carry an asphalt pavement. Immediately upon the cross beams there will be the concrete crowning four inches at the center and one inch at the sides. Upon this will be placed a binder course one in.

thick and then will come the asphalt layer two inches thick. The foot walk shall consist of a 3 inch layer of concrete made with screenings and reinforced with iron netting with $2 \frac{1}{2}$ inch meshes.

DRAINAGE: The bridge shall be crowned transversely as shown in plan and the south end of the bridge shall be three inches higher than the north end.

DEAD LOAD: In determining the weight of the bridge for the purpose of calculating stresses, the weight of the steel will be assumed at 490 pounds per cubic foot, the weight of steel concrete 150 pounds, of concrete 140 pounds, of binder 125 pounds and of asphalt 100 pounds per cubic foot.

LIVE LOAD: In addition to its own weight, the bridge shall be designed to carry a load of 100 pounds per square foot of total floor surface or a steam rooler which shall have five tons on front axle and ten tons on rear axle. The distance between axles to be nine feet.

WIND PRESSURE: The wind pressure will be assumed as acting in either direction horizontally at 50 pounds per square foot of girder.

LEAST THICKNESS OF MATERIAL: No material shall be less than three-eighths inch thick.

PERMISSIBLE TENSILE STRAINS. The sum of maximum loads shall not cause a tensile strain of more than 16,000 pounds per square inch. In calculating tension members, net sections must in all cases be used, and in deducting rivet holes, they should be taken as one-eighth inch larger than the size of rivets.

PERMISSIBLE COMPRESSIVE STRAINS. The sum of maximum loads shall not cause a compressive strain per square inch of more

than $\frac{16,000}{1 + \frac{L^2}{11,000 r^2}}$ in which L is the length of piece in

inches, center to center of connection and r is the least radius of gyration in inches. No compression member shall have a length exceeding 120 times its least radius of gyration.

SHEARING AND BEARING STRAINS. The shearing strain on rivets per square inch of section shall not exceed 12,000 pounds. The bearing strain shall not exceed 24,000 pounds per square inch.

For field riveting the number thus found shall be increased 25%.

FLANGE. One-eighth of the gross area of the web will

be assumed as available for flange area. Both the upper and lower flanges shall have the same sectional area. The unsupported length of flange shall not exceed sixteen times its width. Flange plates shall be fourteen inches wide.

When calculating shearing and bearing strains on web rivets, all the shear acting on the side next to the abutments are to be considered as being transferred into the flange angles in a distance equal to the depth of girder.

SHEARING STRAIN IN WEB PLATES. The shearing strain in the web plates shall not exceed 9,000 pounds per square inch.

STIFFENERS. Stiffeners shall be riveted on both sides of web except where the floor beams are connected to the girders. At these points there shall be two stiffeners on the outside of web placed back to back with an intervening space of three-eighths inch. The stiffeners shall have a close bearing at all points.

SIDEWALK BRACKETS. The side walks shall be supported upon brackets attached to the stiffeners at the floor beam connections with girder, as shown in design and drawings. The web of the bracket shall extend into the intervening space between the stiffener angles.

LATERAL BRACING. The lateral bracing will be made

of angles which will resist both tension and compression.

BED PLATES. The bed plates shall be of such dimensions as to give a pressure upon the masonry of not more than 400 pounds per square inch.

RIVET SPACING. The maximum spacing of rivets shall be six inches and the minimum two and one-fourth inches. The distance from the edge of any piece to center of a rivet shall not be less than one and one-fourth inches.

Three-fourths inch rivets shall be used throughout.

RIVETED WORK. All riveted work shall be accurately punched with holes one-sixteenth larger than size of rivet, and when a built section is put together, the holes must be truly opposite; if the holes must be enlarged to admit the rivet it must be reamed.

All holes for field rivets, excepting those in lateral bracing shall be accurately drilled to an iron templet or reamed while the connecting parts are put together.

RIVETS. The rivet heads shall be of hemispherical shape and of a uniform size for the same rivets throughout the work. They shall be full and neatly finished and concentric with the rivet hole. Wherever possible rivets

shall be machine driven.

NEAT FINISH. The pieces forming a built member must fit closely together and shall be free from twists, bends or open joints when riveted. All portions of the bridge exposed to view shall be neatly finished.

STEEL.

PROCESS OF MANUFACTURE. The steel shall be made by the open-hearth process and if by acid process shall contain not more than 0.08% of phosphorus, and if by basic process, not more than 0.05% of phosphorus, and must be uniform in character.

FINISH. The finished pieces must be free from injurious seams, flaws or cracks and have a clean smooth finish.

TEST PIECES. The tensile strength, limit of elasticity and ductility, shall be determined from a standard test piece, cut from the finished material of at least one-half square inch section. All broken samples must show a silky fracture of uniform color.

MARKING. Every finished piece of steel shall be stamped with the blow identifying the melt.

RIVET STEEL Rivet steel shall have, ultimate strength

48,000 to 58,000 lb. per sq. in. Elastic limit, not less than 1-2 the ultimate strength. Elongation, 26%. Bending test, 180 degrees flat upon itself, without fracture on outside.

MEDIUM STEEL. The medium steel shall have: Ultimate strength 60,000 to 70,000 lbs. per sq. in. Elastic limit, not less than 1-2 the ultimate strength. Elongation 25%. Bending test 180 degrees flat on itself, without fracture on outside.

DRIFTING. Punched rivet holes, pitched two diameters from a sheared edge, must stand drifting until the diameter is one third larger than the original hole without arching the metal.

PAINTING. Before leaving the shop all ironwork shall be thoroughly cleaned from all loose scale and rust and given a coating of a good iron ore paint mixed with pure linseed oil. After being put in place it shall be painted with two additional coats.

CROSS BEAMS. The cross beams shall be made of concrete steel, 6 months before being put into work, so as to give the concrete a working stress of 700 lbs. per sq. in.

The concrete will be of Class (A) specifications for

which are given in, Form (B). The steel will be same as used for bridge material.

HAND RAIL. The hand rail will be made of cast iron and will be as shown in design and drawings.

ASPHALT PAVEMENT.

CONCRETE CROWN. The concrete crown shall be made of Class (A) concrete, specifications for which are given in Form (B), and when being placed should be well tamped.

BINDER. On the concrete foundation shall be laid a binder, consisting of fine bituminous concrete composed of clean broken stone of which at least 50% shall be retained on a one-half inch screen; 50% of this material must be hard, angular stone, and the stone after passing the heating drums, shall not contain less than 5% nor more than 10% of material passing a NO. 10 sieve. In no case shall the binder or asphalt be laid on a wet bottom, or during a rain storm.

The stone shall be heated in suitable appliances not hotter than 350 degrees fahrenheit, and then thoroughly mixed by machinery with the asphalt cement in the proportion of not less than 15 gallons of asphaltic cement

by weight: Refined asphalt 100 parts; heavy petroleum oil 13 to 20 parts. This mixture will form the asphaltic cement. The ratio may be varied according to circumstances as may be necessary to secure the best practical results.

The wearing surface will be composed of: 9 to 15% of asphaltic cement; 88 to 74% of sand; and 3 to 10% of pulverized carbonate of lime.

In order to make the pavement homogeneous, the proportion of asphaltic cement must be varied according to the quality of the sand. The carbonate of lime may be reduced or entirely omitted when suitable sand can be obtained. The sand and asphaltic cement will be heated separately to about 300 degrees fahrenheit. The pulverized carbonate of lime while cold, is mixed with hot sand in the required proportion and is then mixed with the asphaltic cement at the required temperature, and in the proper proportion, is a suitable apparatus; which will affect a thorough mixture.

The pavement mixture will then be laid on the binder in one coat; it will be brought in carts and wagons, at a temperature of at least 250 degrees fahrenheit. It will

then be spread with hot rakes, on the binder, so as to give a uniform and regular grade. After ultimate compression it will be 2 inches thick. The surface will be compressed by a 5 ton roller, after which a small amount of hydraulic cement will be swept over it, and it will then be thoroughly compressed by a steam roller weighing not less than 250 lbs. per lineal inch, the rolling being continued as long as it makes an impression upon the surface.

SAND. The sand shall be same as that used for concrete as given in, Form (B). It shall be of such fineness that 25% shall pass an 80 mesh per inch screen, and 10% shall pass a 100 mesh per inch screen.

SPECIFICATIONS.

Abutments and Retaining Wall.

See Forms A and B.

MATERIAL. The material shall be of Class (B) concrete specifications for which are given in Form (B).

FOUNDATION. The maximum allowable pressure upon the foundation will be 3 tons per sq. ft.

COPING. The retaining and wing walls and the bridge seat shall be finished with a coping, 18 inches deep and projecting 3 inches from face of wall.

BATTER. There will be no batter on the front faces of the abutments, wing or retaining wall, all the battering will be on the back faces.

TOP WIDTH. The top width of wing and retaining walls shall be 1.5 ft. The width of bridge seat shall be 2 feet.

WIDTH OF BASE. In determining the width of the base of abutment, and the greatest widths of the bases of the wing and retaining walls, the Engineering News formula (width = .4 the height) will be used. From this the batter is obtained, after which the width of the remaining portion of the base of the wall is obtained, by using this batter.

PARAPET. A parapet wall 2 ft. 9 in. high and 1.5 ft. thick will be built upon top of abutments.

PLANS. The work shall be constructed in all respects according to design and plans.

FINISH. All parts of the structures exposed to view shall be free from stains and marks left by the forms and shall be neatly finished.

SPECIFICATIONS FOR TELFORD ROAD.

Specifications for a Telford road in Madison, Wis., beginning at the intersection of Washington Ave. and Murray Street and extending to the intersection of Bassett and W. Wilson Streets, a distance of 4,400 feet, 30 feet wide and 12 inches deep.

WORK TO BE PERFORMED. The work to be performed will consist in furnishing all material, tools, machinery and labor necessary for the efficient and proper grading of roadway, side ditches and side banks; laying, spreading and rolling of road material, and leaving the roadway complete in every manner ready for immediate use.

PLANS AND DRAWINGS. The plan, profile and cross-sections on file in the office of the President of the Park and Pleasure Drive Association show general location, profile, detail and dimensions. The work will be constructed in all respects according to the above-mentioned plans, profile and cross-sections, which form part of these specifications.

GRADING. Under this head will be included all excavation and embankment required for the formation of the roadway.

EXCAVATION. The roadway to the width of 30 feet as shown

on plan must be built to the same curvature as that of the surface of the road when finished; the grade, from center to sides, must be as shown on plans.

The grading shall be completed for the full width of the road, from gutter to gutter, before any macadamizing is commenced.

EMBANKMENT. Material for embankment will be that dredged from the bottom of the lake.

The embankment will be formed in layers of one (1) foot, and the material deposited and distributed in such manner as the Engineer may direct, 10% for settling being allowed.

SLOPES. Slopes in embankments shall be two (2) horizontal to one (1) vertical.

SUB-FOUNDATIONS. When the embankments have been brought to a proper depth below the intended surface of the roadway, and the cross-section thereof, conforming in every respect to the cross-section of the road when finished, the same shall be rolled with a ten (10) ton steam roller until approved by the Engineer. If any depressions form under such rolling, owing to improper material, the same shall be removed and good earth substituted, and the whole re-rolled

until thoroughly solid and to above-mentioned grade. Water must be applied in advance of the roller when, in the opinion of the Engineer, it is necessary.

TELFORD FOUNDATIONS. After the roadbed has been formed and rolled, as above specified, and has passed the inspection of the Engineer, a bottom course of stone, of an average depth of six (6) inches, is to be set by hand as a close, firm pavement, the stones to be placed on their broadest edges lengthwise across the road in such manner as to break joints as much as possible, the breadth of the upper edge not to exceed four (4) inches. The interstices are then to be filled with stone chips, firmly wedged by hand with a hammer, and projecting points broken off. No stone of greater length than ten (10) inches or width of four (4) inches shall be used, except each alternate stone on outer edge, which shall be double the length of the others and well tied into the bed of the road; all stones with a flat smooth surface must be broken; the whole surface of this pavement to be subjected to a thorough settling and ramming with heavy sledge hammers, and thoroughly rolled with a fifteen (15) ton steam roller. No stone larger than two and one- half (2.5) inches to be left loose on top of

telford.

FIRST COURSE OF BROKEN STONE. After the roadbed has been formed and rolled as above specified, the first layer of broken stone, consisting of two and one-half (2.5) inch stone, or stone that will pass through a ring three (3) inches in diameter, shall be deposited in a uniform layer, having a depth of three (3) inches, and rolled with a fifteen (15) ton steam roller until compacted to the satisfaction of the Engineer. No stone in this course shall be less than two (2) inches in length. Water must be applied in advance of the roller when, in the opinion of the Engineer, it is necessary.

The depth of loose stone in this course and all other courses must be measured by blocks the required thickness of the said loose stone. These blocks to be placed at frequent intervals amid the loose stone when being spread.

BINDER BETWEEN THE FIRST & SECOND COURSE. On the first course of stone a quantity of screening binder shall be spread in a uniform layer, and the rolling continued until the stones cease to sink or creep in front of the roller; water will be applied in advance of the roller, if ordered by the Engineer. The quantity and quality of this binder.

and all other binding to be at all times subject to the approval of the Engineer.

SECOND COURSE OF BROKEN STONE. The second course of broken stone shall consist of one and one-half (1.5) inch stone; that is every piece of stone shall be so broken that it can be passed through a ring two (2) inches in diameter, and no stone shall be more than two (2) inches nor less than one (1) inch long. This course is to be spread in a uniform layer three (3) inches in depth, and rolled until thoroughly settled into place to the satisfaction of the Engineer. Water will be applied if ordered by the Engineer.

BINDER ON SECOND COURSE. The binder on this course of stone must be applied in the same manner as the binder on the first course of stone.

SURFACE. When the two courses are rolled to the satisfaction of the Engineer a coat of fifty (50) per cent. of three-quarters ($\frac{3}{4}$) inch stone and fifty (50) per cent of screenings, properly mixed, is to be spread of sufficient thickness to make a smooth and uniform surface to the road, then again rolled until the road becomes thoroughly consolidated, hard and smooth.

The rolling is to be done by the Contractor with

a fifteen (15) ton steam roller approved by the Engineer. Any depressions formed during the rolling, or from any other cause, are to be filled with one and one-half (1.5) inch stone or three-quarter ($\frac{3}{4}$) inch stone, or both, and screenings approved by the Engineer and the roadway brought to the proper grade and curvature as determined by him.

Water must be applied in such quantities and in such manner as directed by the Engineer.

MANNER OF ROLLING. In the rolling the roller must start from the side lines of the stone bed and work towards the center unless otherwise directed. The rolling shall at all times be subject to the directions of the Engineer.

QUALITY OF MATERIAL. All stone must be as nearly cubical as possible, broken with the most approved modern stone-crushing machinery, free from all screenings, earth and other objectionable substances, of uniform size and of the same kind and quality, or equally as good in every particular, as that shown in the Engineer's office. The one and one-half (1.5) inch stone, three-quarter ($\frac{3}{4}$) inch and screenings for binder and final finish must be of the best trap rock, free from loam or clay.

The Contractor must furnish samples to the

Engineer of the kind of stone to be used in the work before the opening of bids.

SHOULDERING. A shoulder of gravel is to be left or made on each side, extending at the same grade and curvature of the road to the gutters.

GUTTERS. The gutters are to be excavated as per stakes furnished by the Engineer, in order to give an easy flow of water, so that no water shall be left standing on the road or in the gutters.

UNDERDRAINS. Under-drains, if found necessary, shall be constructed by the Contractor (at prices named in bids) of good four (4) inch tile.

NO EXTRA PRICE. No allowance in depth of pavement will be made on account of any material which may be driven into the roadbed by rolling. The pavement when completed must conform to the grade and the cross-sections and be satisfactory to the Engineer, whose decision shall be final.

All gravel for shouldering or binder and all extra hauling is to be done at the Contractor's expense.

LIABILITIES OF CONTRACTOR. He shall maintain sufficient guards by day and night to prevent accidents from travel and will be liable for any damage which may arise from his

neglect to do so, or from any omission on his part.

He shall keep the road sprinkled until the final certificate of completion by the Engineer is given.

He is to commence and prosecute the work upon the road at such points as may be directed by the Engineer within ten (10) days from and after the signing of the contract, and shall continue work thereon until completion, except as herein provided.

He further agrees to complete the same on or before the day of A. D. Twenty dollars for each day that the work shall remain uncompleted, after the time allowed by contract, may be deducted, as liquidated damages, from any moneys due Contractor, unless otherwise agreed upon by the Park & Pleasure Drive Association, after presentation of the certificate of the Engineer recommending the extension of the time limit of completion.

The Contractor shall keep the finished roadway and earth work in repair for the period of one (1) year from the date of its completion and acceptance, during which time he shall be liable for wear and tear caused by ordinary travel, and in addition thereto, for as much longer as for any period or periods during said year it shall be out of

telford.

FIRST COURSE OF BROKEN STONE. After the roadbed has been formed and rolled as above specified, the first layer of broken stone, consisting of two and one-half (2.5) inch stone, or stone that will pass through a ring three (3) inches in diameter, shall be deposited in a uniform layer, having a depth of three (3) inches, and rolled with a fifteen (15) ton steam roller until compacted to the satisfaction of the Engineer. No stone in this course shall be less than two (2) inches in length. Water must be applied in advance of the roller when, in the opinion of the Engineer, it is necessary.

The depth of loose stone in this course and all other courses must be measured by blocks the required thickness of the said loose stone. These blocks to be placed at frequent intervals amid the loose stone when being spread.

BINDER BETWEEN THE FIRST & SECOND COURSE. On the first course of stone a quantity of screening binder shall be spread in a uniform layer, and the rolling continued until the stones cease to sink or creep in front of the roller; water will be applied in advance of the roller, if ordered by the Engineer. The quantity and quality of this binder

and all other binding to be at all times subject to the approval of the Engineer.

SECOND COURSE OF BROKEN STONE. The second course of broken stone shall consist of one and one-half (1.5) inch stone; that is every piece of stone shall be so broken that it can be passed through a ring two (2) inches in diameter, and no stone shall be more than two (2) inches nor less than one (1) inch long. This course is to be spread in a uniform layer three (3) inches in depth, and rolled until thoroughly settled into place to the satisfaction of the Engineer. Water will be applied if ordered by the Engineer.

BINDER ON SECOND COURSE. The binder on this course of stone must be applied in the same manner as the binder on the first course of stone.

SURFACE. When the two courses are rolled to the satisfaction of the Engineer a coat of fifty (50) per cent. of three-quarters ($\frac{3}{4}$) inch stone and fifty (50) per cent of screenings, properly mixed, is to be spread of sufficient thickness to make a smooth and uniform surface to the road, then again rolled until the road becomes thoroughly consolidated, hard and smooth.

The rolling is to be done by the Contractor with

a fifteen (15) ton steam roller approved by the Engineer. Any depressions formed during the rolling, or from any other cause, are to be filled with one and one-half (1.5) inch stone or three-quarter ($\frac{3}{4}$) inch stone, or both, and screenings approved by the Engineer and the roadway brought to the proper grade and curvature as determined by him.

Water must be applied in such quantities and in such manner as directed by the Engineer.

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The Contractor must furnish samples to the

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GUTTERS. The gutters are to be excavated as per stakes furnished by the Engineer, in order to give an easy flow of water, so that no water shall be left standing on the road or in the gutters.

UNDERDRAINS. Under-drains, if found necessary, shall be constructed by the Contractor (at prices named in bids) of good four (4) inch tile.

NO EXTRA PRICE. No allowance in depth of pavement will be made on account of any material which may be driven into the roadbed by rolling. The pavement when completed must conform to the grade and the cross-sections and be satisfactory to the Engineer, whose decision shall be final.

All gravel for shouldering or binder and all extra hauling is to be done at the Contractor's expense.

LIABILITIES OF CONTRACTOR. He shall maintain sufficient guards by day and night to prevent accidents from travel and will be liable for any damage which may arise from his

neglect to do so, or from any omission on his part.

He shall keep the road sprinkled until the final certificate of completion by the Engineer is given.

He is to commence and prosecute the work upon the road at such points as may be directed by the Engineer within ten (10) days from and after the signing of the contract, and shall continue work thereon until completion, except as herein provided.

He further agrees to complete the same on or before the day of A. D. Twenty dollars for each day that the work shall remain uncompleted, after the time allowed by contract, may be deducted, as liquidated damages, from any moneys due Contractor, unless otherwise agreed upon by the Park & Pleasure Drive Association, after presentation of the certificate of the Engineer recommending the extension of the time limit of completion.

The Contractor shall keep the finished roadway and earth work in repair for the period of one (1) year from the date of its completion and acceptance, during which time he shall be liable for wear and tear caused by ordinary travel, and in addition thereto, for as much longer as for any period or periods during said year it shall be out of

proper condition. If, during that time, the roadway or any part of the work shall, in the judgment of the Engineer, require repairing, and he shall duly notify the Contractor to make such repairs as required, and the Contractor shall refuse or neglect to do so to the satisfaction of the said Engineer, within five (5) days from the date of service of notice, then the said Engineer shall have the right to have the work done properly by other parties and pay the expense for the same out of the five (5) per cent. retained.

The Contractor will be required to preserve all stakes and bench marks made and established on the line of work until duly authorized by the Engineer to remove the same.

STOPPING WORK ON ACCOUNT OF WEATHER. The Engineer may stop any portion of the work if, in his judgment, the weather is such as to prevent the same being done properly. No allowance of any kind will be made for such stoppage, except an extension of the time for the completion of the work, as herein provided.

ABANDONMENT OF CONTRACT. If at any time the work under contract should be abandoned, or if at any time the Engineer should judge and so certify in writing that said work, or

any part thereof, is unnecessarily delayed, or that the Contractor is wilfully violating any conditions or covenants of this contract, or is executing the same in bad faith, then, and in that case the Association shall notify the said Contractor to discontinue all work under this contract. They may employ other parties to do the work in such manner as they may decide and use such material as may be procured upon the line of aforesaid work, and, if necessary, to procure other material for its completion, and charge the expense of the said labor and material to the Contractor, which expense shall be deducted from any moneys due him under contract. In case these expenses shall exceed the sum which would have been payable under contract, if the same had been completed by said Contractor, he or his bondsmen shall pay the amount of the excess to the Association, on notice from the Engineer.

INSPECTION. All directions and determinations necessary to give due and full effect to any of the provisions of these specifications shall be given by the Engineer.

All material and workmanship of any kind shall be subject at all times to the inspection of the Engineer. Whenever unfaithful and imperfect work is discovered, it

shall be immediately repaired or replaced by the Contractor, after due notification from the Engineer.

PAYMENTS. Monthly payments will be made by the Association to the Contractor for work performed, on presentation by him of the proper certificates of the Engineer in a sum not to exceed eighty (80) per cent. of the amount then due, together with releases from all liens, if required. Fifteen (15) per cent. will be paid at the completion of the work. The remainder of five (5) per cent. will be retained for a period of one (1) year, as herein provided for.

CONTRACTOR TO INSURE PAYMENT FOR LABOR, MATERIAL, ETC., ON FINAL ESTIMATE. The Contractor must also furnish said Engineer with satisfactory evidence that all persons who did work, or furnish material for this contract, or who has sustained damage or injury by reason of any act, omission, or carelessness on his part or his agents in the prosecution of the work, have been duly paid or secured; he shall also give notice to said Engineer within ten (10) days after the completion of the work, and before final estimate is made, that any balance for such work or materials, or compensation for such damages due, has been fully paid or

released.

Bond.

Know All Men by These Presents, that
 of the of
 County of Dane and State of Wisconsin, as principal, and
 and , as sureties,
 are held and firmly bound unto the Park and Pleasure Drive
 Association of Madison, or its assigns, in the sum of
 dollars, lawful money of the United States
 of America, for which payment will and truly to be made, we
 bind ourselves, our and each of our heirs, executors, and
 administrators, jointly and severally by these presents.

Sealed with our seals, and dated this
 day of, 1905.

Now, therefore, if the above bounden principal
 shall so guard the work and material during the progress
 thereof, that no injury, loss or damage shall occur to per-
 sons or property, and shall save the Park and Pleasure Drive
 Association of Madison harmless from such injury, loss, or
 damage, if any shall occur on account of not guarding the
 premises when work is being done, and shall observe all
 clauses in the specifications relating to safety and have
 completed the work to conform to the specifications and

such damages as may have been deemed necessary and all claims for material and workmanship be paid, then this obligation to be void, otherwise of full force and virtue.

.....Seal

..... Seal.

.....Seal.

Approved by the Park and Pleasure Drive Association, ..., 1905.

.....

President.

State of Wisconsin)
)
 County of Dane) ss
)
 City of Madison.)

..... and
 of Madison, Wis., and, sureties of the
 principal named in the foregoing bond, being duly sworn,
 each for himself, deposes and says he is worth in unincum-
 bered property, not exempt from execution under the laws of
 this State, the sum
 dollars, after payment of all just debts, claims and liabili-
 ties.

Subscribed and sworn to before me this
 day of 19...

.....

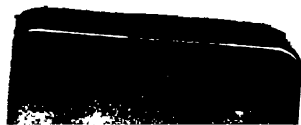
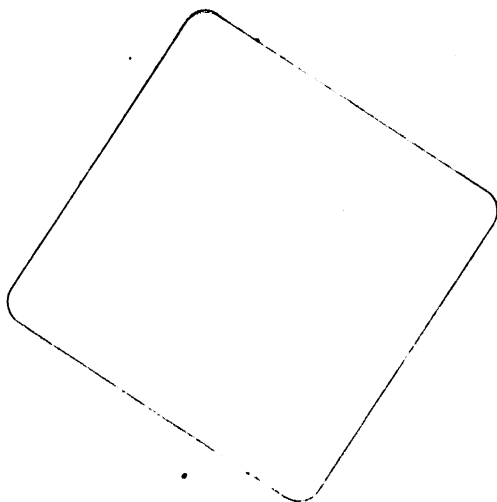
 Notary Public in and for Dane County, Wisconsin.

Approved by, *M. D. Raykar*.....
Prof. P. V. Edupaty.....
.....

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